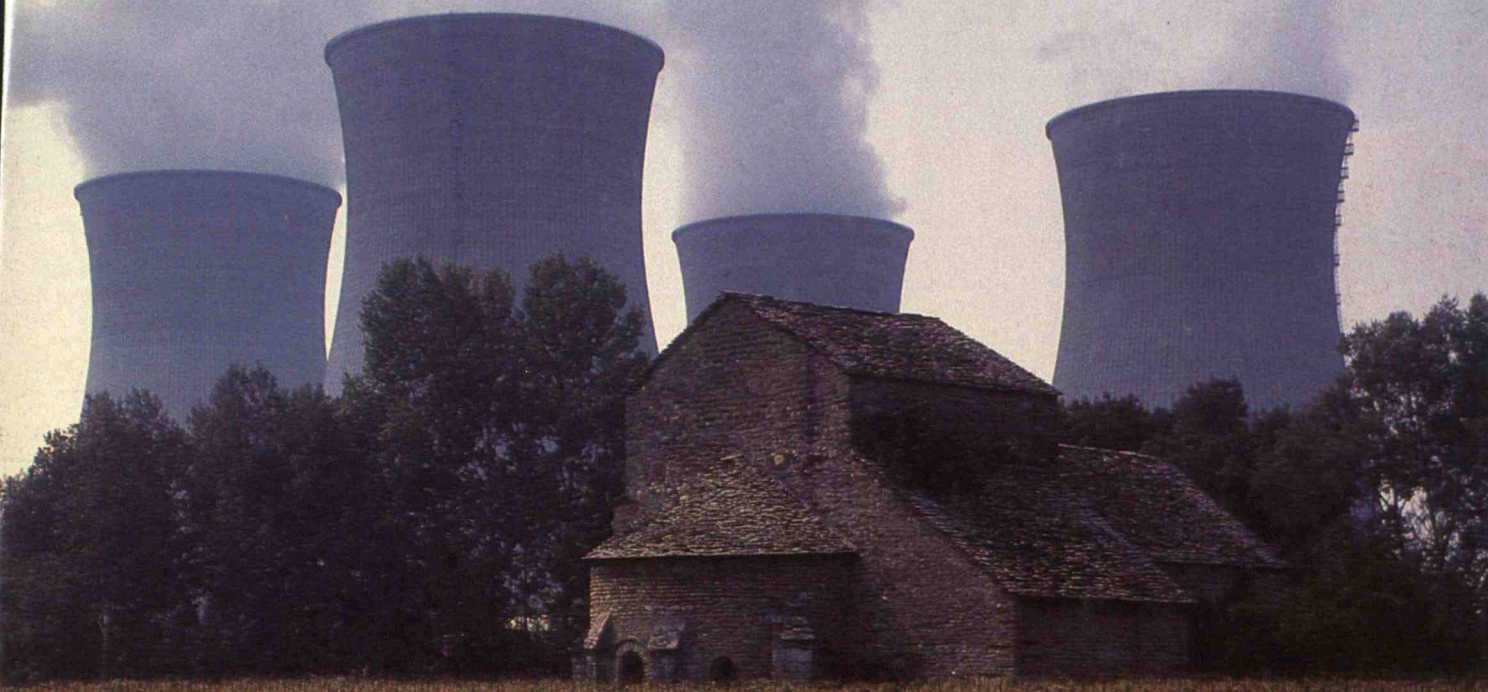
♦ THE CRISIS IN GOVERNMENT STATISTICS ♦ DAVID BALTIMORE ON AIDS ♦

♦ BIODEGRADABLE PLASTICS ♦ SCIENCE AND HUMAN RIGHTS ♦

Technology Review

EDITED AT THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY FEBRUARY/MARCH 1989 $3.00



Where Nuclear Power Works

♦

NEW LESSONS FROM AROUND THE WORLD

AN MIT REPORT

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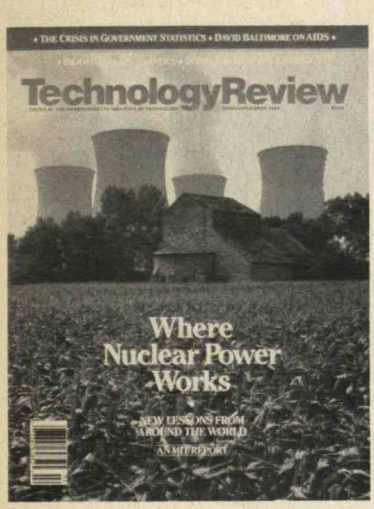
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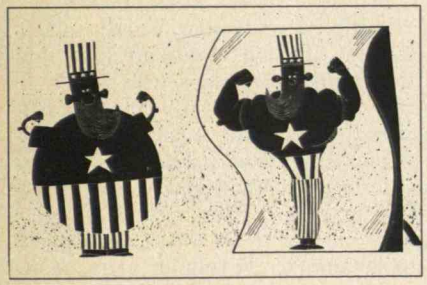
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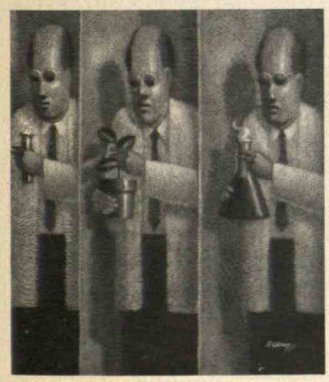
TechnologyReview



30 NUCLEAR POWER



52 GOVERNMENT STATISTICS



24 AIDS RESEARCH



69 DEGRADABLE PLASTICS

30 **MAKING NUCLEAR POWER WORK: LESSONS FROM AROUND THE WORLD**
BY KENT HANSEN, DIETMAR WINJE, ERIC BECKJORD, ELIAS P. GYFTOPOULOS, MICHAEL GOLAY, AND RICHARD LESTER
An international study shows that the key to improving the performance of U.S. nuclear plants lies in managerial reform.

42 **SCIENTISTS AS DETECTIVES: INVESTIGATING HUMAN RIGHTS**
BY CLYDE COLLINS SNOW, ERIC STOVER, AND KARI HANNIBAL
Forensic scientists have long defended human rights. Now they are using their skills to aid victims of state terror.

52 **DISTORTED IMAGE: HOW GOVERNMENT STATISTICS MISREPRESENT THE ECONOMY**
BY HENRY KELLY AND ANDREW WYCKOFF
Trying to build an information economy on bad information won't work.

62 **IN THE EYE OF THE BEHOLDER: POETIC DOCUMENTARIES ABOUT TECHNOLOGY**
BY KAREN ROSENBERG
Two West Berlin filmmakers have startling perspectives on the way technology and ideology have meshed in this century.

69 **DESIGNING PLASTICS THAT DEGRADE**
BY ANN GIBBONS
Mounting litter and concern about harm to wildlife have spurred efforts to create disintegrating plastics.

2 **FIRST LINE**

7 **LETTERS**

10 **TRENDS**
Testing Airplanes—Gently
Chernobyl Fallout
Advances in Integrated Circuits
Stalking the Wild Thunderbolt
High-Tech Help
Managing the Oceans
Mini-Trends

COLUMNS

22 LANGDON WINNER
Criteria for judging sports technologies such as drugs are unclear and unfair.

24 DAVID BALTIMORE
The way scientists organize research hampers progress on AIDS.

FORUM

26 SHEILA JASANOFF
Public critiques of government research can make for better regulations.

REVIEWS

74 VIDEO
The Computer's Future

76 BOOKS
The Tribe of Physics

80 **MIT REPORTER**

COVER
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FIRST LINE

FROM THE EDITOR

The Character of a Magazine



THOUGH editor of *Technology Review* for only a few months, I have already lost track of how many mission statements I've been asked to write. I'm afraid the results have not been altogether consistent or satisfactory, and for good reason. A magazine is like a human: one can detail its character in retrospect but can only discern hints of it in advance. In fact, it is a bad plan to stick too mechanically to any plan. Nevertheless, I think it is useful for me to set down at this point my sense of the nature of this magazine.

Technology Review lies somewhere between a professional journal and the mass media but is fundamentally different from both. Journals, whether for hydraulic engineers or literary critics, accept common jargon and assumptions. Our audience is the general public, so we insist that authors speak plain English and justify assumptions. The mass media report what experts say, a process of simplification. We ask individuals intimate with a subject to speak directly to general readers. As MIT's magazine, we bridge the schism between the academy and the public.

Technology Review belongs to the honorable tradition of the intellectual magazine. Others of our genre range from *Foreign Affairs* to *Issues in Science and Technology*, from *The Sciences* to arts magazines such as *The New Criterion*. Few have circulations much above 100,000, but they are often read intensively and used widely. Our articles are reprinted and cited daily by professors, community groups, newspapers, and television. In the 1940s when Dwight McDonald edited *Politics*, he felt isolated comparing the few thousand who subscribed with the millions who didn't. In the 1950s he ran across so many nostalgic readers that, he said, "I have the impression that I'm better known for *Politics* than for my articles in *The New Yorker*."

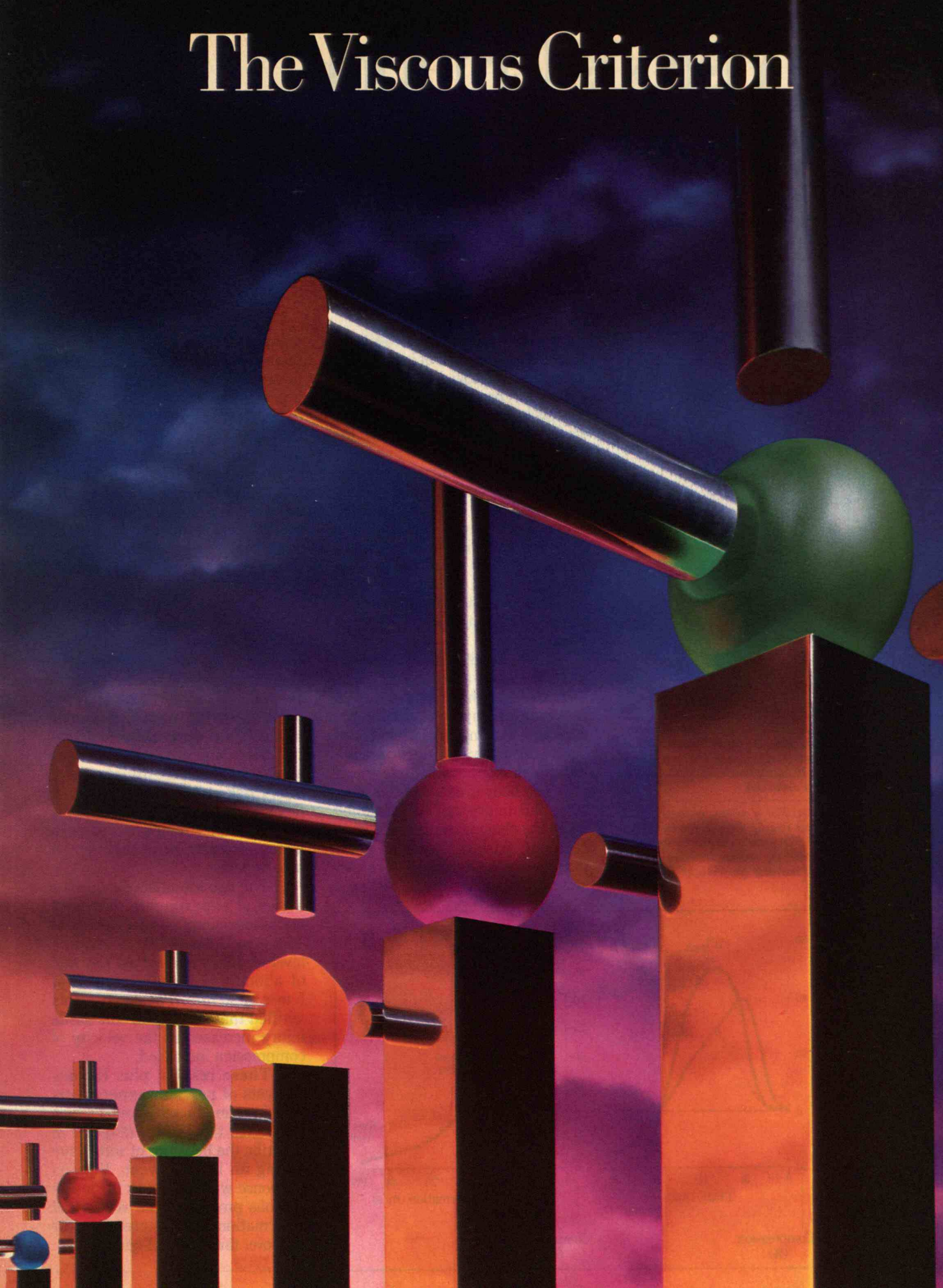
This magazine treats technology as a deep channel in the mainstream of intellectual discourse. We shouldn't have to say that we are a magazine of technology and society, for technology is inherently social. Just as there can be no law without a society, so there is no disembodied artifact. When we find archaeological remains, we are not content until we reconstruct the society to which they belonged.

A magazine is the crossroads of a community—ours includes MIT and all those who care deeply about technology in our world. Members of this community will disagree with one another, sometimes sharply. Since the editors do not claim to know the final truth, we welcome all responsible voices. We insist only that authors present reasoned opinions and be meticulously factual. If they are able at the same time to satisfy both the rigorous demands of their peers and the inquisitiveness of the general reader, the results can be extraordinary. Finally, the editors hope that the discussions carried on in these pages will help make a better world.



JONATHAN SCHLEFER

The Viscous Criterion



The Viscous Criterion

Two scientists at the General Motors Research Laboratories have developed a way to predict the probability and severity of impact injuries in the body's soft tissues, including the heart, liver, and the central nervous system. It is an essential step in designing safety systems to reduce such injuries.

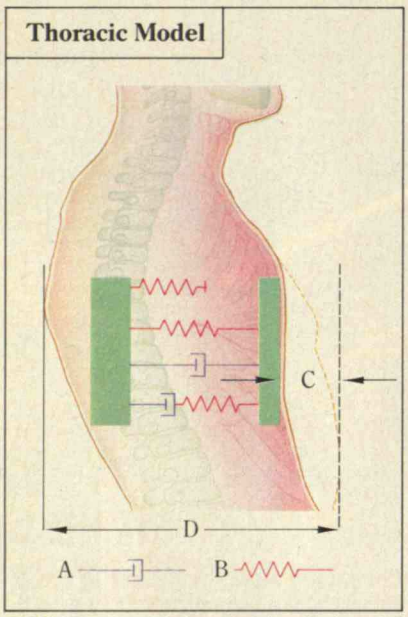


FIGURE 2: Lateral view of a viscoelastic model of the human chest. Dashpot elements (a) and spring elements (b) represent thoracic compliance. Compression (C) is expressed as a percentage of original chest depth (D).

Designing an automobile to reduce the risk of injury to its occupants in a collision demands an ability to correlate the forces generated by the crash with the biological effects experienced by the people involved.

Military rocket sled experiments in the late 1950s measured man's ability to withstand sudden changes in speed. The resulting Acceleration Criterion was used in setting 60g (60 times the force of gravity) as the maximum spinal acceleration allowable under federal motor vehicle standards in a 30 mph crash test.

This Acceleration Criterion treats the body as a rigid structure. Over the years, however, subsequent research on injury mechanisms indicates that injury criteria based on whole-body acceleration are incomplete predictors of injury risk.

The body is a deformable structure, and injury can be sustained when the chest is compressed in an accident. At low speeds of deformation (less than 3 meters per second), the tolerance to rib cage damage and the risk of injury correlate closely to the maximum compression of the chest—expressed as a percentage of the original chest depth from sternum to spine. This Compression Criterion, developed in the early '80s by GM researchers in conjunction with the University of California at San Diego, is useful in evaluating injury risk for safety-belted occupants, where tight coupling to vehicle deceleration reduces the amount of chest compression in a collision.

Doctors Ian Lau and David Viano—both members of the Biomedical Science Department of the General Motors Research Laboratories—began in 1981 to evaluate the importance of velocity in assessing the risk of impact injury. They were concerned that the maximum compression tolerance might underestimate chest injury risk at high speeds of chest deformation (greater than 3 m/s)—typical of unrestrained occupants in a frontal crash, or in high-speed side impacts.

The two scientists designed a series of experiments that held maximum compression constant at 16%—well below the tolerance level of 35%—and varied the rate of abdominal compression from 5 m/s to 20 m/s. The experiments verified that severity of soft tissue injury increased as the velocity of compression increased.

These results, plus further analysis of previous experiments, led Viano and Lau to develop a function called the *Viscous Response* to describe the behavior of soft tissue during an impact event. Viscous Response was defined as the instantaneous product of the velocity of deformation and compression, varying over time: VC(t) (Figure 1A).

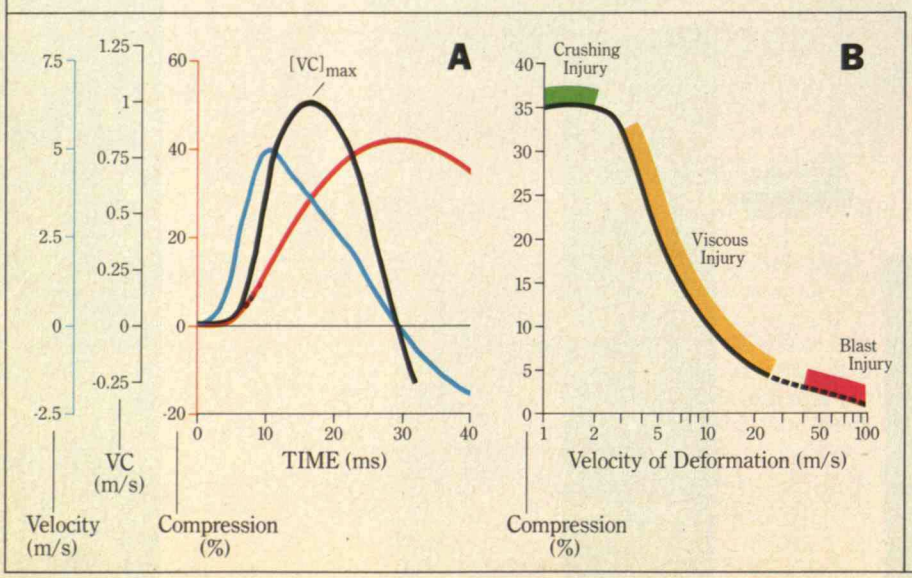


FIGURE 1: A) Plot of viscous response, VC(t), during impact (black). C(t)=normalized compression (red). V(t)=rate of chest deflection (blue). $[VC]_{max}$ defines the Viscous Criterion. B) Range of validity for Viscous Criterion (yellow).

The mathematical form of the Viscous Response is derived from analysis of a mechanical analog of the viscoelastic response of the human thorax. (Figure 2). The dashpots (2a) represent the behavior of viscous soft tissue, while the springs (2b) correspond to the elastic skeletal response to impact.

In computing impact energy absorbed by the analog, the dominant term is the product of velocity of deformation and compression, with compression defined as chest deflection normalized by the original chest depth, (Fig. 2, D). Therefore, the Viscous Response is related to absorbed energy.

Drs. Viano and Lau suspected that the injury mechanism for soft tissue was also related to absorbed energy, and designed further experiments to verify the predictive abilities of the peak Viscous Response (VC_{max}). In these tests, velocities of deformation ranged from 5 m/s to 22 m/s and maximum chest compressions ranged from 4% to 55%. Analysis of the test data showed that the maximum Viscous Response was an accurate predictor of injury risk for the entire data set. In addition, VC_{max} was the only biomechanical response that adequately defined injury risk for the full range of test conditions, including the extremes of only 4% compression at 22 m/s, as well as 55% compression at only 5 m/s.

Investigation across this range of deformation velocities effectively links together existing knowledge of crushing injuries, high-speed impact injuries, and data available on blast injuries (Figure 1B).

Applying the Viscous Criterion to previously published blunt frontal impact data, Lau and Viano used statistical analysis to show that VC_{max} was highly correlated with the risk of severe injury. "For velocities of chest deformation above 3.0 m/s," says Dave Viano, "VC_{max} is the principal indicator of injury, whereas for very slow speeds of deflection, the Compression Criterion assesses crushing injury risk. We are, therefore, recommending a viscous tolerance for the chest of VC_{max} equal to 1.00 m/s, and a compression tolerance of C_{max} equal to 35% to minimize the risk of severe injury in an accident."

Ian Lau points out the importance of such risk assessments as targets for automotive designers. "Based on our new awareness of the mechanism of soft tissue injury, General Motors has already designed a self-aligning steering wheel that can be an excellent countermeasure for reducing abdominal injuries in a crash."

The new wheel works in concert with the energy-absorbing steering column, and is available as standard equipment on the 1989 Chevrolet Cavalier. Says Lau, "This is an excellent example of engineering and medical science working together. And because GM is the only auto maker with a biomedical research facility and a dedicated staff of research professionals, it can only happen here."

General Motors

GM

MARK OF EXCELLENCE



THE MEN BEHIND THE WORK:

David C. Viano and Ian V. Lau are both members of the Biomedical Science Department at the GM Research Laboratories.

Dr. Viano (right) is a Principal Research Scientist, leading the department's Safety Research Program. Dave received his BS in Electrical Engineering from the University of Santa Clara; he holds both an MS and a Ph.D. in Applied Mechanics from the California Institute of Technology. Dr. Viano joined GM in 1974 following postdoctoral work in Biomechanics at the Swiss Institute of Technology. His interests include technologies to improve occupant protection, the biomechanics of trauma and disability, transportation safety, and public health approaches to injury control.

Dr. Ian Lau came to the Research Laboratories in 1978, and is now a Senior Staff Research Engineer. Ian has a BS in Electrical Engineering from Lowell University. He holds a Ph.D. in Biomedical Engineering from the School of Medicine of the Johns Hopkins University. Ian was also a Postdoctoral Fellow of the American Heart Association at the Hopkins School of Hygiene and Public Health. His other research interests include traumatic cardiac arrhythmias, and occupant interaction with the steering and supplemental restraint systems.



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TECHNOLOGY AND AGING

After more than 15 years of retirement in a community with one of the nation's highest percentages of elderly, I feel qualified to challenge Frank Bowe's views on seniors' reluctance to use technology (*August/September 1988*).

I have no quarrel with the part of his analysis that centers on lack of money. I am surrounded by folks whose ability to obtain medical and physical help depends entirely on whether Medicare and other insurance will pay for it. However, I disagree with the notion that we oldsters are somehow ashamed of our afflictions—that it is better, in our judgment, to do without rather than wear a hearing aid or heart monitor and thereby admit we need one.

As a frequent retirement-home visitor, I often see just the opposite attitude: folks who can manage a walker if they must but prefer to be pushed in a wheelchair. People still at home exhibit another problem: they tend to avoid any sudden change in lifestyle.

Here I speak from a personal viewpoint. I would be well served by a computer for word processing, a telephone-answering unit, and several other household conveniences. My reluctance to buy them is not based on economics or concern about appearing equipment-dependent to my friends. It is purely and simply the impulse to live each day as an extension of yesterday.

E. SCOTT PATTISON
Dunedin, Fla.

Frank Bowe's remarks notwithstanding, seniors avoid products targeted at the infirm because of the "FOD" factor—fear of death. Researchers have found that the classic infirmities of old age become acute in the last few years of life. Consciously or subconsciously, seniors may make the connection between increasing infirmity and death. After all, they see empirical evidence as their friends become feeble and die. Counteracting such a powerful fear is a tall order for conventional product marketing.

GEOFF FOULDS
Toronto, Ontario

Bowe's article seems to neglect some important points that are best appreciated by older people. As we age, our value in society is diminished, and our bodily frailties, of increasing importance to us, become "social problems" to younger people. We weigh applying novel solutions to our difficulties against what might happen if we fail.

Also, people pay less attention to seniors than to others. Bowe concludes from his own mother's reluctance to use technology that she doesn't want to call attention to her need for "special help." Perhaps he should consider the possibility that she is delaying accepting his advice as a way of getting him to pay more attention to her.

GAVIN ALEXANDER
Sindelfingen, West Germany

PLANET MANAGEMENT

I appreciated "The State of the World: An Interview with Lester Brown" (*July 1988*). There is, however, a serious flaw in Mr. Brown's statements.

While the reduction the Chinese have made in expenditures on weaponry is clearly good news, they've yet to become party to the treaties limiting nuclear-arms testing and possession.

The financial and technical aid institutions affiliated with the United Nations have obviously become increasingly attuned to the observations of organizations like Worldwatch. But dismayingly, the debt restructuring and austerity programs imposed by the World Bank and the International Monetary Fund have not required any reductions in developing nations' defense expenditures, even where justified. To the contrary, the military and industrial prowess of Indonesia, India, Brazil, and Egypt are lauded and given the same economic justifications asserted by the developed nations.

BRUCE ROSEN
New York, N.Y.

The provocative interview with Lester Brown prompts me to note that one potential solution to the greenhouse effect is rarely mentioned. The overlooked alternate is simply to take the carbon dioxide out of combustion gases and store it. Meyer Steinberg of Brookhaven National Laboratory has written an evaluation of this idea, and he appears to conclude that known technologies could remove 50 percent of the carbon dioxide from the flue

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LETTERS

gas of large stationary sources. He indicates that the cost of doing so would be approximately equal to the current cost of generating electricity. That may not be too high a price to pay to avert what may be a totally restructured climate.

J.F. MATHIS
Summit, N.J.

PORK BARRELS IN SPACE

Like all the other articles I have read about the space program, "The U.S. Space Station: A Quarter-Century of Evolution" by Philip D. Hattis (*July 1988*) alludes to benefits that might be derived from a space station but mentions nothing substantive. In fact, all the factors involved in space-station activities mitigate against ever finding benefits equal to the costs. Also, a planned $24 billion expenditure will become $240 billion, for sure.

When I think about the $200 billion spent on putting men on the moon, I can find nothing that we the people received. So why does this tremendous waste of money continue? Because it is a terrific pork barrel, and pork barrels have been the only significant achievement of Congress in the past 30 years.

R.W. LILLIE
Granada Hills, Calif.

GLOSSING THE ECONOMIC BUZZWORD

Langdon Winner's "Let Them Eat Competitiveness" (*August/September 1988*) takes a narrow view of a concept-turned-cliché. Competitiveness may be an economic buzzword, but the vision behind it is valid.

While the primary goal of our competitors in the Pacific Rim is indeed customer satisfaction, the main goal of much of America's work force is to make it to 5:00 on Friday. If we are careless in satisfying the needs of consumers, other countries will avail themselves of the opportunities such indifference will provide.

BARRY C. COLEN
San Rafael, Calif.

Langdon Winner's first column is a doozer. His point that American firms seeking to remain competitive seem willing to close plants and offices at home and open similar ones offshore is a telling one. What is especially embarrassing is that the flow of jobs offshore has arisen from the attempt of U.S. companies to compete with each other for the U.S. market.



DON HORNER
Holly, Mich.

NAME THAT DEFENSE EXPENDITURE

"Hard Choices" by Michael Klare and David Callahan (*October 1988*) leaves me wondering if the two authors did their homework. On page 58, is that not a Cobra being called an Apache? And on page 60, the caption claims that you can pick up an F-14 Tomcat for a cool $9 million (please tell the Pentagon where), yet on the same page the realistic price tag of $32 million is there in black and white. My guess is that the picture shows the F-4 Phantom, not the Tomcat.

I can just see Klare defending our country with a P-38 (can opener) and his buddy Callahan out on a nighttime ambush carrying an M-60 (tank). We all make mistakes, but no one subscribes to mine.

JASPER McELWEE
Malibu, Calif.

We thank Mr. McElwee for his close read of our captions—which are written by us, not the authors—and apologize for our errors. That is indeed not an Apache on page 5, and an F-14 does cost about $32 million.—Ed.

TRENDS-SECTION TRENDS

Technology Review's Trends section has shown a distinctly anti-nuclear trend in recent months. "Nuclear Un-News" (*May/June 1988*) is itself a piece of un-news. So what if one television documentary presents an even remotely positive view of nuclear power? Having sat through a dozen blatantly one-sided anti-nuclear "documentaries" on network television in the past 10 years, I found "Nuclear Power: In France, It Works" a welcome relief.

As for NBC's failure to report the injuries of seven French nuclear plant workers, what about the hundreds of occupational accidents in other industries that go unreported on network news every year?

DONALD A. DUBE
New Britain, Conn.

BURNING QUESTIONS

In "Blazing Satellites" by Steve Nadis (*May/June 1988*), Richard Custer, director of the Center for Fire Safety Studies at Worcester Polytechnic Institute, suggests that Halon 1301, the active chemical in the space shuttle's fire extinguisher, is toxic and corrosive. Nonsense.

Halon 1301 is stable when stored but decomposes when heated above 1,000°F. Suppose a fire occurs in a computer room or a spacecraft. The advantage of the material is that it can put out the flames but still leave enough oxygen for people to breathe while they escape.

Custer further states that "you can't just throw hazardous chemicals overboard" to decontaminate a spacecraft. Of course you can! When *Skylab* was crippled during its launch, scientists feared that toxic gases had been generated inside. The solution was simply to vent the craft's atmosphere and then repressurize it.

FRANK J. WEIGERT
Wilmington, Del.

Richard Custer responds:

The comment on Halon toxicity and corrosivity Mr. Weigert refers to is not a quote from my interview but a conclusion the author drew from it. Nonetheless, his letter raises important technical issues that merit clarification.

Halon has different properties in its natural state and after decomposition. For example, natural Halon is not corrosive, while decomposed Halon is. On the other hand, Halon has toxic effects in both the natural and decomposed states. Experience and testing have shown that when Halon is in its natural state, people exposed to high concentrations may suffer from dizziness, loss of coordination, and cardiac disturbances. Low concentrations can produce the same effects, but only if exposure lasts for more than 15 minutes.

Mr. Weigert is correct in saying that Halon decomposes at elevated temperatures, and in fact the heat from fires can easily exceed 2,000°F, yielding decomposition products such as halogen acids and free halogens. These are not only corrosive but more toxic than natural Halon. Fire protection for Halon systems requires prompt evacuation, and possibly warning signs and breathing apparatus as well.

Certainly hazardous chemicals could be thrown overboard. But experience with the space shuttle indicates that the materials may remain in the area.

Articles worth reading are worth reprinting.

THESE IMPORTANT ARTICLES FROM *TECHNOLOGY REVIEW* ARE NOW AVAILABLE IN REPRINT FORM:

- ☐ "SUPERCONDUCTORS: THE LONG ROAD AHEAD," by Simon Foner and Terry P. Orlando. February/March, 1988.
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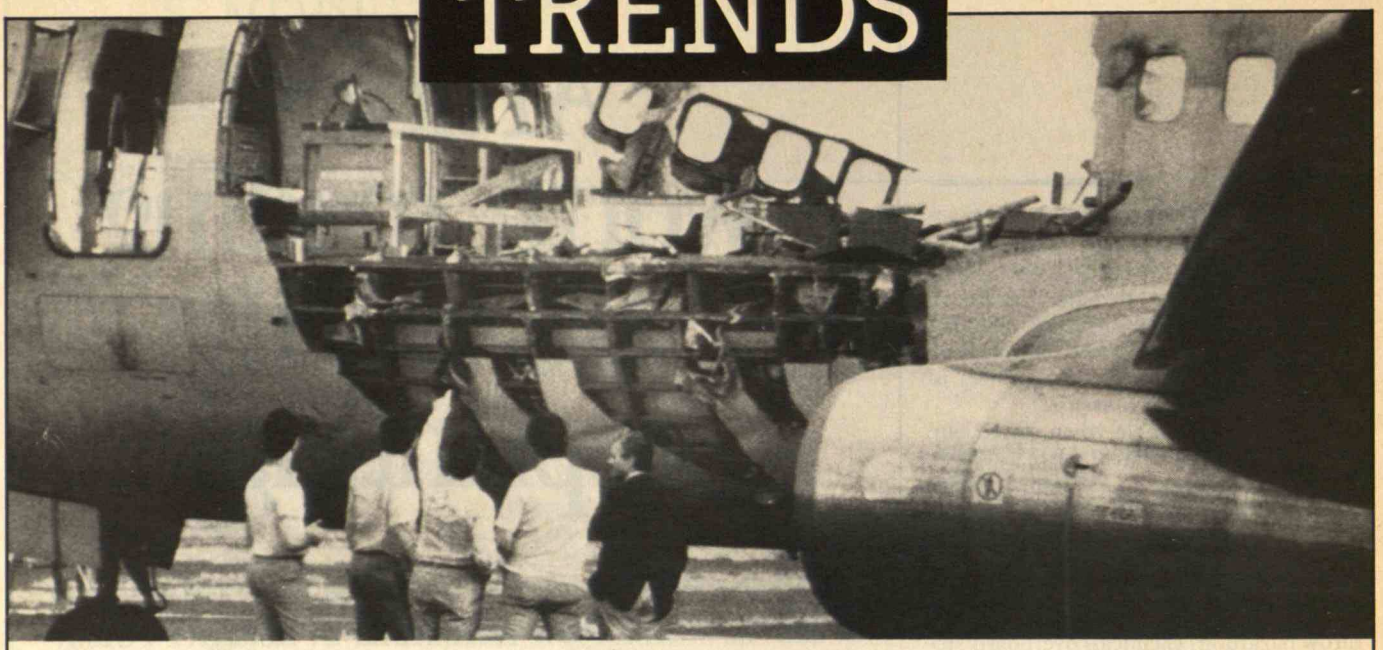
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Detecting Threats to Airplane Safety

The fuselage of Aloha Airlines flight 243 ripped open last year. Airlines hope to prevent such accidents by testing planes for flaws.

In the middle of the night, airport technicians x-ray doors, send high-frequency sound into bolts, and examine wheels and rivets with electromagnetism. The goal is to detect cracks before they threaten safety. Today, all commercial aircraft undergo "non-destructive tests" (NDTs) to uncover flaws that age brings about in metal.

Designing ways to test a plane throughout its lifetime is integral to designing the aircraft itself. The plane must be strong enough to prevent undetectable cracks from threatening safety or performance. "If you can detect a crack that's half an inch long," then a wing might be riddled with quarter-inch cracks, points out MIT professor of aeronautics Paul A. Lagace.

In addition to direct visual inspection, three main nondestructive tests protect aircraft: eddy-current probes, high-frequency pulses, and x-rays. "Eddy current is our primary method for finding fatigue cracks," says Douglass Aircraft's Douglas J. Hagemaier, known as the father of NDT in aviation. Each time a commercial airliner's tires are changed—roughly once a month for DC-9s—an eddy-current tester electronically inspects wheel hubs, a special danger point during takeoff and landing.

The eddy-current probe resembles a small pen. Connected to a screen, the probe fits into a "shoe" that follows the contour of the wheel. "The probe produces a magnetic field, which induces a small current in the wheel itself," says Roger Hamelin, USAIR's lead inspector in Boston, explaining that "any flaw in the wheel will obstruct that current." Eddy currents can find cracks five-eighths of an inch below the surface.

Eddy-current techniques also inspect the lap joints where rivets connect one aluminum panel to another. Sometimes corrosion destroys the bond that reinforces the joint, Hagemaier notes, as happened to Aloha Airlines Flight 243 in 1988. When the Boeing 737's cabin pealed apart, a flight attendant was whisked to her death. According to Hagemaier, when the bond weakened, "the stress went into the rivet joints, and they started to crack because they were overloaded. You have numerous cracks in a line, and the thing just unzips like a piece of toilet paper."

Larger parts—such as the U-shaped shackles securing ailerons, flaps, and spoilers—are tested by sending high-frequency pulses into metal and listening to the echoes. "It takes a certain amount of time for the signal to get from the top of the bolt to the bottom," says Joseph Garza, USAIR's inspection supervisor. "If you have a crack, the signal gets back faster."

On parts too large or complex for ultrasound, inspectors find cracks the same way doctors find them in bones—with x-rays. But while medical x-rays tend to be 50 to 150 kilovolts, aircraft are blasted with 200 to 300 kilovolts.

On DC-9s, x-rays augment a more informal test. The back-door plates sometimes crack after thousands of pressurizations, and often telltale brown tobacco stains from escaping air reveal the defects. But "we are getting that less and less" as people smoke less, Garza observes. Instead of relying on smokers, the FAA mandates x-rays every 1,000 to 15,000 landings, depending on the door's history.

X-rays are also used to examine jet-engine combustion chambers. In a vault at its Atlanta Technical Operations Center, Delta Airlines keeps a highly radioactive capsule of iridium-192. Technicians place x-ray film around engine parts and put the capsule inside the engine. The two-hour procedure reveals cracks half an inch long, says Marvin Morris, NDT foreman for Delta's quality-control division. Regulations allow engine cracks eight inches long.

Firsthand Views

Because handling highly radioactive iridium is dangerous, other airlines prefer direct visual inspection. At USAIR's Boston hangar is a collection of long tubes with eyepieces on the end called borascopes. Inside each tube are two fiber-optic bundles—one carries light in, and the

Continued on page 12

PHOTO: BETTMANN NEWSPHOTOS

Hughes Aircraft Company was the recipient of the U.S. Army Award for outstanding achievements in Value Engineering for cost-savings. In 1987, Hughes Value Engineering Change Proposals (VECPs) saved customers over 53 million dollars. Since 1964, 735 Hughes VECPs on 53 programs have resulted in a total savings of 1.136 billion dollars. Some of the programs benefitting from the VECPs include F/A-18 avionics, Maverick, Phoenix, and Advanced Medium Range Air-to-Air Missiles, M1 Abrams Tank, Bradley Fighting Vehicle, and the AN/UYQ-21.

A new Space Based Radar Program will involve the placement of a constellation of sensor platforms in the Earth's orbit between 600 and 6,000 nautical miles in altitude for wide area surveillance of ships, aircraft, and cruise missiles. Hughes, as a member of the Grumman-led team, will define technology requirements and an implementation plan for the radar RF and processing sections, which will interface with Grumman's SBR system. An operational demonstration-validation phase will lead to a first launch in the mid-1990's. The Space Based Radar Program is a joint U.S. Air Force and Navy program.

An infrared sensor system for the joint services' V-22 Osprey aircraft will help crews navigate and land in darkness and during periods of poor visibility. The Infrared Detection Set (IDS), developed by Hughes, senses small differences in radiated heat and provides a TV-like image of the surrounding area. The V-22, the first of the new tilt-rotor aircraft for the U.S. Armed Forces, is able to take off and land like a helicopter, but fly like a plane. Hughes will start flight testing the IDS in early 1989, with flight test support continuing through 1991.

A weather satellite in geosynchronous orbit above the Atlantic seaboard "sees" cloud cover even at night. The Geostationary Operational Environmental Satellite (GOES) H, built by Hughes, sees through a combination telescope and sensing instrument called a visible-infrared spin scan radiometer atmospheric sounder (VAS). Developed by Hughes, the VAS uses reflected visible light and infrared thermal radiation to gather images of Earth and its atmosphere. The last in a series of five weather satellites, GOES H watches for storms that threaten the East coast.

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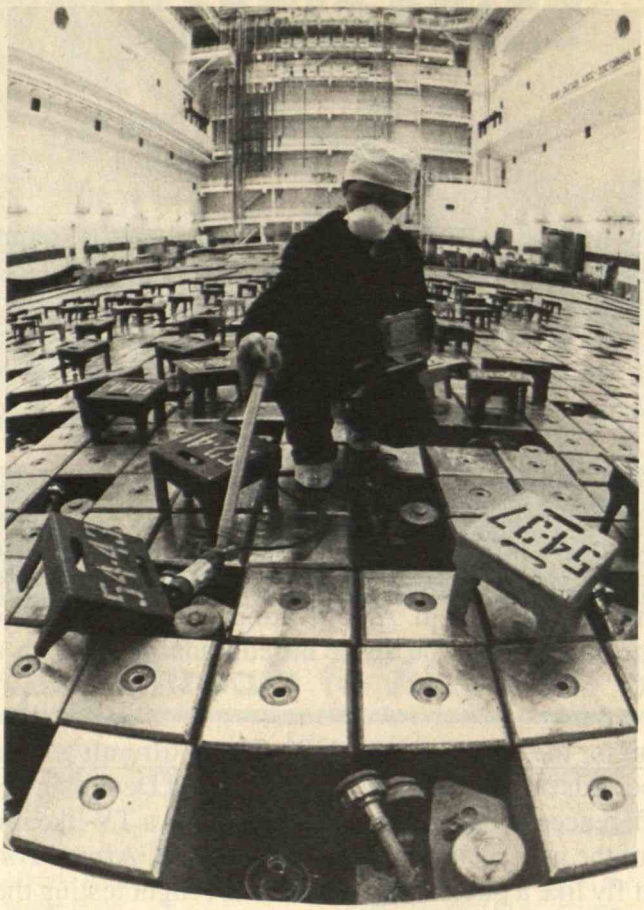
other carries the image out. "This takes the place of the isotope x-rays," Garza says. "We get much better definition and it's much safer." USAIR's newest borascope has a dime-sized television camera at the end of a six-foot cable. Technicians insert the cable through the engine's spark-plug holes and snake it about with pressurized air.

"A person can go out and borascope an engine, store [the image] on tape, transfer it by telephone line to Tulsa, and then an engineer here can look at the blades to see what the conditions are," says Burl Nethercutt, a project engineer at American Airline's NDT lab. "The engineer doesn't have to listen to somebody describe over the telephone what the problem is. He can see it firsthand."

In the future, "electronic sheerography" could uncover flaws inside an airplane body or wings. Developed by Laser Tech of Norristown, Pa., this technique combines holography and electronic image processing. First, a laser beam spread by a special lens illuminates a part, says Laser Tech president John Newman. Then the air pressure is lowered slightly to stress the part, and a computer monitors changes in its shape. If there is a flaw, one section bends more than another.

Finally, thermography NDT is just in the laboratory stage. "We take a source of heat, like a heat lamp or heat gun, and blow it on one side," says Robert Green, director of at the John Hopkins Center for Non-Destructive Evaluation. An infrared camera watches the part as it is heated. According to Green, a flawed part won't heat uniformly.

SIMSON GARFINKEL is a freelance writer based in Cambridge, Mass.



Chernobyl Fallout

What health threat is posed by the small amount of radon in your home? Or by living near a nuclear plant? And what will be the health legacy of the Chernobyl disaster? These questions result from the hotly disputed topic of the dangers from low doses of so-called ionizing radiation.

The most controversial view belongs to statistician Jay Gould, an advisor to the Environmental Protection Agency during the Carter administration, and University of Pittsburgh radiologist Ernest Sternglass. They suggest that 35,000 to 40,000 more Americans died in the summer of 1986 than could be expected from previous mortality statistics. Analyzing the deaths by geographical region, the researchers believe the results closely correspond to Chernobyl fallout.

To add to the controversy, Sternglass cites research by California ornithologists, who found that bird populations fell dramatically during the same period. For 11 years, researchers at Point Reyes Bird Observatory have counted the "reproductive success" of various species. Estimates based on environmental factors such as rainfall had indicated that more birds than usual would have been born in 1986. But the populations of most species dropped 62.3 percent from the 10-year mean.

Sternglass says this corroborates his theory that extremely low levels of ionizing radiation can be harmful. The mechanism, he says, is that even extremely little radiation produces "free radicals," oxygen molecules that have an extra electron. Even in tiny amounts, these charged oxygen molecules have been shown to damage the body's immune system. Sternglass points out that the additional deaths in 1986 were not cancers. "They seem to have occurred in people with illnesses dying a little sooner, people suffering from pneumonia, heart disease, and AIDS."

In the volatile atmosphere of the debate, Arthur Upton, former head of the National Cancer Institute, accuses Sternglass of "selecting bits of data that fit his hypothesis." And most researchers contend that Chernobyl produced far too little ionizing radiation in the United States to see any health effects. Even John Gofman, an outspoken advocate of tighter radiation standards, says that while he respects the statistical work, "I just don't believe their conclusions."

A medical physician and biophysicist from the University of California at Berkeley, Gofman says that countries like Germany, with hundreds of times the U.S. fallout, haven't reported markedly higher numbers of deaths. Nevertheless, no one has been able to explain the unusual mortality data.

While few experts go as far as Sternglass and Gould, a growing body of data suggests that small amounts of ionizing radiation may be much more harmful than previously anticipated. But how much?

In part, the debate is intense simply because the implications are great. Even by current measures, a recent Environmental Protection Agency assessment of radon dangers estimates that the radioactive gas may cause 20,000 cancer deaths each year.

PHOTOS: TASS/SOVFOTO

Louis Slesin, editor of a newsletter about non-ionizing radiation, likens the question to a minefield. For example, many researchers continue to analyze data from Hiroshima and Nagasaki, but a controversial question is how to extrapolate the effects of prolonged, lower doses from that. And even when increased deaths or disease are shown, a causal link to low-level radiation is very difficult to prove.

Changing Standards

Regardless of these difficulties, many experts now believe that international radiation standards are not stringent enough. Last fall 800 scientists, including two Nobel laureates and a Manhattan Project participant, petitioned the International Commission on Radiological Protection (ICRP) to tighten its standards for worker exposure to radiation by a factor of five.

Currently, the ICRP and many national radiation safety bodies set "acceptable" exposure levels. Most challenges to this reigning approach focus on the "dose response curve"—whether a large radiation dose has the same effect as an accumulation of smaller doses that equal the same total exposure. Even without accepting the Gould-Sternglass assertions of effects from infinitesimal doses, evidence is mounting that ionizing radiation damage is "supra-linear"—that is, low doses are disproportionately dangerous.

Recent support for this view came from a team of scientists at Japan's Radiation Effects Research Foundation and the University of Texas Health Science Center. The investigation found a strikingly high cancer rate among people who were exposed as fetuses to radiation from the Hiroshima and Nagasaki explosions. The team documented a rate almost four times that of a control group, with many cancers appearing years after exposure.

Other studies indicate that relatively low levels of ionizing radiation can have a significantly greater effect upon children, infants, and fetuses, Gofman adds. For example, he says that large-scale studies by British epidemiologist Alice Stewart documented serious damage to fetuses. Commenting that the impact seems to plateau after the age of 15 or so, Gofman suggests it "must have something to do with maturing tissue." But he notes that no theory adequately explains the plateau.

Nor has anyone explained why a supra-linear model might apply to adults, a problem Gofman calls "the $64,000 question." But he believes that it does. By extrapolating data from Hiroshima and Nagasaki, Gofman thinks the hazards of low-level exposure to ionizing radiation may be 30 to 40 times greater than current standards assume.

This view, however, remains controversial. For example, Upton supports efforts to extrapolate from existing data, but he doubts they will definitively solve questions of radiation risk. For that, he says, "We need to learn how the effects are produced, and this will probably come from a study of mechanisms in experimental animals and model systems." ■

SETH SHULMAN is a regular contributor to Trends.



Scientists debate the dangers of low-level radiation, such as fallout from the accident at Chernobyl. At left, the reactor shop chief at Chernobyl Unit 1 measures radiation levels in May 1986. At right, the Chernobyl reactor soon after the accident that April.

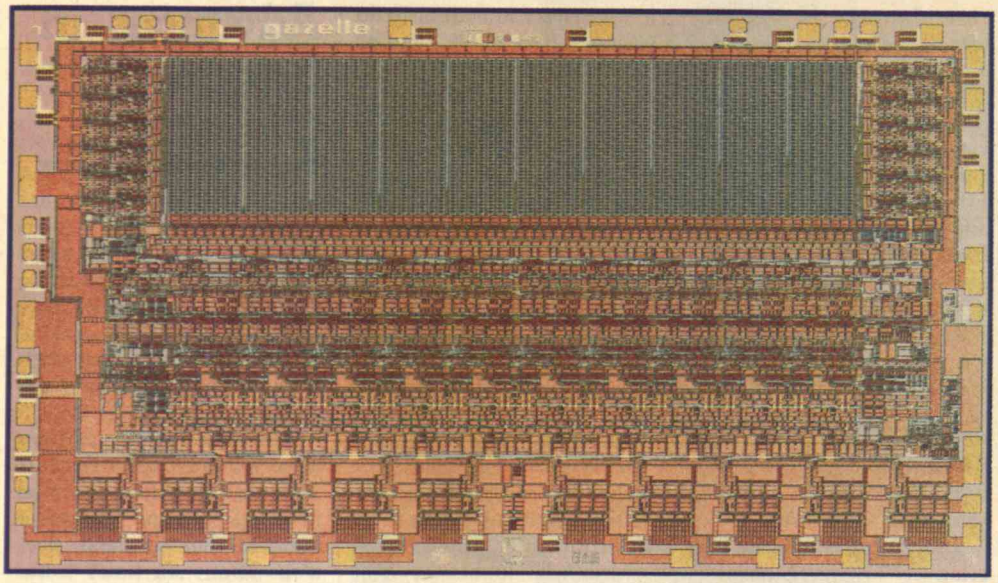
Advances in Integrated Circuits

In the race to produce more powerful computers, attention has turned to integrated circuits that combine rat poison with a by-product of aluminum refining.

Researchers have known since the late 1950s that arsenic and gallium combined in equal portions produce a material that conducts electrons about six times faster than silicon, requires as little as one-fourth the power, and resists radiation damage ten times better. With recent headway on manufacturing technology, many U.S. companies—including IBM, Digital, Sun Microsystems, Convex Computers, Apple, Data General, and Prime—are investigating using gallium arsenide in integrated circuits for the next decade.

Cray Research has announced that its newest supercomputer will contain about 48,000 gallium-arsenide chips. The machine, scheduled to be available next year, will perform 16 billion calculations a second. That's about three times as powerful as Cray's 1988 model. "When Cray was looking at the next jump in speed, silicon had become too expensive," says Larry Smarr, director of the National Center for Supercomputing Applications at the University of Illinois.

Smarr predicts that gallium arsenide will profoundly alter the computer industry. Besides its high speed and low power needs, gallium arsenide is ideal for light-emitting diodes and was applied in las-



Gallium-arsenide semiconductors help computers run faster and more efficiently.

ers as early as 1962. Silicon emits heat rather than light; gallium will emit either. Cruise missiles, supermarket bar-code readers, and most compact-disc players now incorporate gallium-arsenide lasers.

Holographic Weaponry

At Hughes Research Lab in California, senior staff physicist George Valley is working with gallium arsenide in real-time holography for "smart" weapons, enhancing satellite images, and advanced computer graphics. Lasers capture images that can then be stored in gallium-arsenide devices for modification, filtering, enhancement, or merging with other views.

However, the alloy's drawbacks have been daunting. Gallium is very difficult to purify, says David Rogers, a project chemist with Johnson Matthey Electronics, a Canadian manufacturer of gallium arsenide. "You can hold it in your hand and it will melt like an ice cube," he says. Gallium melts at 80°F and boils at 2,403°F, says Rogers, "the broadest liquid range of any element." Moreover, it dissolves other metals, further complicating purification and increasing manufacturing costs. And gallium-arsenide chips have been broken too often by production workers used to sturdier silicon.

Even gallium arsenide's speed has worked against it. Dave Whitmire, manager for gallium-arsenide systems at Texas Instruments, explains that a silicon-dominated computer system cannot be converted easily to a gallium-arsenide system. The differences in speed and power would require a different system design. "The whole architecture has to be reworked. And that's millions of bucks."

Finally, the need for mass-produced gallium-arsenide semiconductors has been delayed as silicon chips improve dramatically, allowing manufacturers to imprint more circuits on smaller chips. While the Defense Department and telecommunications giants could afford and justify the expense of gallium arsenide's special abilities, the commercial sector has largely ignored the difficult material.

Hybrid Chips

Now the prospects for gallium arsenide are rising. Basing the next generation of computer workstations—the so-called superminis—on silicon might require prohibitively expensive cooling systems. Selectively incorporating gallium-arsenide chips could help keep machines small and prices competitive.

Nor is the conversion problem insurmountable. Companies like Gazelle Microcircuits and Vitesse Semiconductor manufacture replacement gallium-arsenide semiconductors modeled upon silicon circuits. Apple, Sun, Stratus, Data General, and Digital Equipment are Gazelle customers. "Our devices run more than two times faster than the closest silicon device," says Robert Gunn, product marketing manager at Gazelle. But the price is twice as high, too.

That should improve. Robert Linares, president of Spectrum Technology, a Massachusetts-based gallium-arsenide foundry, cites gallium purification processes introduced in the late 1970s. He also says improved chip fabrication technologies have reduced the cost of gallium-arsenide circuits substantially. *High Technology Business* estimates the price of production has dropped 20-fold since 1985. And, says Linares, "We have not yet felt the economies of scale."

Linares believes that too much emphasis has been placed on the conflict between gallium arsenide and silicon. He calls gallium-arsenide chips "simply another class of semiconductor that can perform some functions that silicon can't, or can't perform as well." Gigabit Logic, which made the chips for the new Cray computer, expects gallium arsenide will displace silicon in applications requiring high speed and low power, while silicon will be used in low-cost memories.

In fact, researchers are investigating coating silicon with gallium arsenide, combining one material's speed with the other's durability. Texas Instruments has interconnected gallium-arsenide and silicon transistors on a single silicon slice. This could herald chips that merge inexpensive silicon memories with high-speed gallium-arsenide operations. ■

THOMAS KIELY is a frequent contributor to Technology Review.

PHOTO: GAZELLE MICROCIRCUITS

Stalking the Wild Thunderbolt

Across the United States, lightning kills about 100 people each year, sets a thousand fires, and causes tens of millions of dollars in damage. For obvious reasons, pilots, electric companies, beachgoers, and many others would like to know more about nature's fiery discharge.

Toward that end, computers at the National Lightning Detection Network are monitoring bolts that strike the ground in the United States. In the next decade, satellites observing the entire globe could help meteorologists predict where, when, and how strongly the flashes will hit.

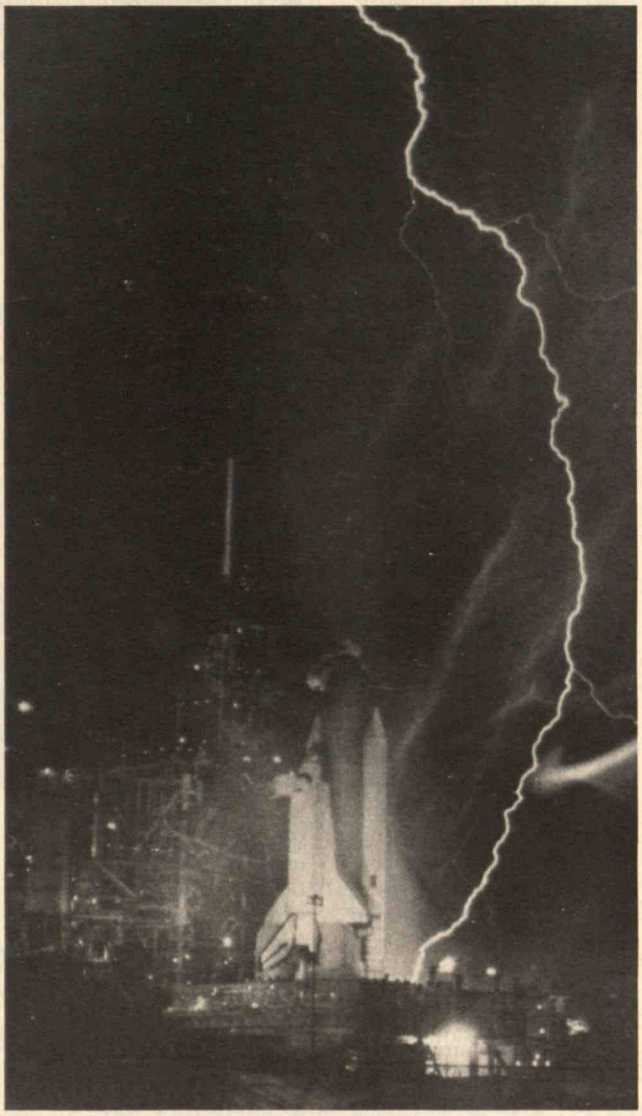
Since lightning is a major cause of power outages, the utility industry's Electric Power Research Institute (EPRI) is the main supporter of the network, which is based in Albany, N.Y. For about $6,000 per year, subscribers get up-to-the-minute information about approaching storms. They use the data to position repair crews. "We can't stop [lightning], but we can at least be ready for it," says Herbert Songster, manager of EPRI's lightning research.

Completed in late 1988, the network has 114 detectors across the continental United States linked by telephone and satellites. Researchers have analyzed more than 20 million flashes since the first antennas went into operation five years ago. The antennas pick up lightning's electromagnetic disturbances in much the same way that a car radio does during a thunderstorm, explains network director Richard Orville, a professor of atmospheric science at the State University of New York at Albany.

The equipment not only counts the number of times lightning strikes the ground but also measures the direction and strength of a flash. In addition, it computes the number of surges within each flash and determines if a flash flows from cloud to ground or the reverse.

Orville has gained a number of insights from data collected by the national network. For example, he has discovered that the percentage of so-called positive flashes, in which electrons move from the ground to a cloud, is much higher in winter than summer. Positive flashes also have higher peak currents, making them much more dangerous.

However, fundamental questions remain. Scientists still don't understand precisely how electrical storms form, travel, and dissipate. They know that a typical cloud-to-ground bolt begins in a cloud with an excess positive charge at its top and negative charge at its bottom, but what causes the charges to separate and how they ignite lightning remains enigmatic. Nor do scientists know why lightning zigzags in such unpredictable patterns.



Dazzling lightning preceded the 1983 space-shuttle launch. NASA wants to learn more about how lightning threatens spacecraft.

PHOTO: NASA

Lightning Laboratories

NASA has its own interest in resolving these uncertainties. In 1969, lightning struck Apollo 12 seconds after liftoff, temporarily disabling the craft's electrical systems. And on March 26, 1987, a bolt destroyed an Atlas-Centaur rocket shortly after launch. The Apollo 12 incident "caught us all by surprise," says Bill Jafferis of the Kennedy Space Center. "We didn't hear thunder or see lightning, yet the spaceship triggered it."

Jafferis manages NASA's six-year-old Rocket Triggered Lightning Program. During thunderstorms, it launches dozens of three-foot-tall rockets trailing wires that spark lightning. "We can control the conditions for a lightning strike in the same manner as a lab experiment," Jafferis explains. Investigators analyze the bolts, seeking to decipher how clouds develop charge, how far lightning will travel, and why lightning strikes one object rather than another.

In part, NASA wants to know when it is safe to conduct a launch. At one time,

electrical activity five miles away was considered safe, according to Jafferis. "But I've triggered lightning that has come all the way from Daytona Beach, 30 miles away," he says.

For the mid-1990s, NASA is preparing the Lightning Mapper Sensor, an experiment scheduled to fly aboard an environmental satellite that will maintain a stationary orbit covering the continental United States. NASA hopes to eventually orbit three or four sensors, enough to study global lightning activity and measure it over relatively isolated regions such as the tropics. Complementing the Albany-based network, NASA's mapper sensor will record all lightning strikes, not just cloud-to-ground. About three-fourths of all lightning never touches the ground, jumping from cloud to cloud or flashing within a single cloud.

One goal of global coverage will be to determine "flash rates," the number of bolts that occur in a given time span. Measurements taken from airplanes suggest that both a storm's strength and total precipitation are directly proportional to the flash rate, says Hugh Christian, who is developing the sensor at NASA's Marshall Flight Center in Huntsville, Ala.

"We hope to learn how thunderstorm and lightning activity changes as a function of location, time of day, and season," Christian says. He predicts the satellite sensor will shed light on such diverse questions as how solar flares affect thunderstorms and whether lightning-generated nitrogen oxides destroy ozone in the stratosphere. ■

STEVE NADIS is a regular contributor to Trends.

High-Tech Help

On a placid street in New York City's Greenwich Village, a mechanical designer and four young engineers share a cramped electronics lab. Part of the National Technology Center of the American Foundation for the Blind (AFB), the lab invents and adapts products to ease life for America's 2 million blind and visually impaired citizens.

The lab's most recent innovations are talking machine-shop tools—calipers, height gauges, analytical scales, and carpenter's levels, all suitable for blind professionals or hobbyists. The level, for example, beeps in different tones to reveal which way a piece of wood is leaning; it falls silent when the wood is even.

The lab dates from the early 1930s, when the AFB launched its talking-book program, which now records 50 titles a year for the Library of Congress. Over the next four decades, the lab concentrated on consumer products, such as Braille household appliances, stencils for signing checks, and large-digit clocks—all of which the AFB still markets.

By the 1970s, however, the AFB saw the potential of state-of-the-art technology. The lab began to combine synthesized speech with other small microprocessor-based devices. Among the results were a talking thermometer for a human body—or a roast in an oven. In the 1980s, since diabetes is a leading cause of blindness, the lab adapted a blood-sugar monitor so that its readings were audible. Another 1980s creation is a hand-held talking wallet, which "is cheaper than persuading the Treasury to put tactile clues on money," says center director Elliot Schreier. A computer engineer, he used to work on NASA's space-shuttle telescope but decided he preferred "using engineering to help people."



Speech pathologist Joan Tanenhaus uses computer technology to help Katina Howard, who has cerebral palsy, learn to communicate.

The lab is now developing even more advanced tools: a talking scientific calculator, an optical reader to scan and read aloud almost any digital display, and a "power minder" that beeps every minute an appliance is turned on. Costing under $20, this last device could appeal to the sighted as well as the blind.

Schreier thinks the next challenge will be adapting cutting-edge computer technology, such as the mouse and icons that operate Macintosh computers. These innovations—some of which are now in phones and bank machines—make computers easier to use, but they pose obstacles for blind people.

Keyboards and printers have long been adapted for Braille, and Schreier sees no reason why computer icons can't be made audible or tactile. In addition, the mouse could be enclosed in a tactile grid that would allow blind users to track the mouse's movements.

Talking by Touch

While AFB relies on young engineering talent, the United Cerebral Palsy Association of Nassau County (UCPN), about 40 miles east of New York, draws older experts seeking a change or a useful retirement. Ron Arroyo, an electrical engineer who used to work for the Veterans Administration, adapts the toys for UCPN's lending library. He says the challenge is to discover what people can do and teach them how they can use technology to help themselves.

Cerebral palsy, caused by prenatal injury or birth trauma, can result in a wide range of physical disabilities, from a slight limp to complete paralysis and speechlessness. But even victims who can't talk may still be perfectly capable intellectually and able to learn to communicate in other ways. The battery-run, switch-operated mechanical toys in the UCPN library ad-

PHOTO: UNITED CEREBRAL PALSY ASSOC. OF NASSAU CO.

just to suit a child's abilities, providing a first step toward communicating.

In a preschool class, special educator Sue Rosen oversees children learning to operate a simple computerized device that allows them to send a spoken message. This "light talker"—two rows of four pictures each—sits on the armrests of a child's wheelchair. By hitting a switch with a hand, head, or knee, a child can light up one of the eight icons to send a simple audible message. For example, when a child selects a picture of the Cookie Monster, the computer says, "I'm hungry."

Next door, six- to nine-year-olds work with more elaborate light talkers that have four times as many pictures and messages. Robbie, age nine, cannot control his hands but can press a switch with his knee. Chris, six, can use his hands freely. Asked, "How are you?" he grins and has his computer answer, "I feel yucky."

Finally, Charlotte Plotnick, who heads the communications lab, asks Peter, a slight man in his forties with no hand control, to demonstrate devices with programs that can be tailored to a user. In a non-talking system that Arroyo built, a code combines colors and numbers. Each combination corresponds to a simple message: "Yes," "No," or "I'm fine." As a light scans a row of colored boxes, Peter uses his head to stop the scanner at the color he wants. The light then automatically scans a column of numbers, and Peter flips the switch when it reaches the one he wants.

Peter also demonstrates a light talker with 59 icons and commands. This system allows him to combine phrases and form relatively complex messages. For example, when Peter stops the scanning light at a television icon and at a spot that reads "Let's talk," a computerized voice says, "Let's talk about the television program."

Software for other computerized devices at UCPN recognizes a user's patterns in combining phrases. The more a user communicates with this kind of program, the faster the device comes up with messages. And in the eye typer, one of the most advanced systems, an infrared beam helps people who can control only their eyes. A small target reflector rests on the user's cheekbone. By focusing the eyes on part of a computer keyboard, a person can spell out messages that are heard aloud.

However, even this sophisticated equipment is laboriously slow. Like the inventions from the American Federation for the Blind, UCPN's devices illustrate how far technology could go in the future. ■

ANN MARIE CUNNINGHAM is co-author of Future Fire: Weapons for the Apocalypse *(Warner, 1983).*

DAEDALUS

HOW TECHNOLOGY RECREATES A LEGEND



THE STORY OF MIT'S TRIUMPHANT DAEDALUS PROJECT IS NOW AVAILABLE IN REPRINT FORM

On April 23, 1988, after three years of planning, testing and perfecting technology, a 70-pound aircraft called *Daedalus* was pedaled 72 miles from Crete to the island of Santorini—breaking the record for human-powered flight.

John Langford, the project manager for the journey across the Aegean, tells how his team combined technology with perseverance to achieve this new world record.

Because of the popularity of Langford's article, it is available in reprint form. Considered by many to be the most in-depth article on the subject, it allows you to relive this historic event. The reprint is filled with stunning full color photographs that capture the making of the flight.

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Managing the Oceans



If Peruvian fishers had known more about marine ecology, their catch would not have suffered in the past 16 years.

Peruvian fisheries produced 12 million tons of processed anchoveta in 1970, up from a little more than 100,000 tons in 1950. But after a severe El Niño event in 1971 and 1972 brought warm waters, the catch of this small variety of anchovy fell to 2.3 million tons in 1973, and it has failed to reach 5 million tons ever since. In 1973, the industry, once Peru's leading export, lost nearly $110 million.

International demand did not decline—the supply did. In fact, doubts about the sustainable level of Peru's anchoveta fishery first appeared in the early 1960s, when fisheries experts began to realize how sensitive the area is to environmental changes. They estimated that only about 8.5 million tons could be harvested year after year.

The region is an example of what is now called a large marine ecosystem (LME). If Peruvian fishers had better understood how El Niño events temporarily destroy the productivity of their region's normally cool, upwelling waters, the anchoveta industry might never have collapsed, according to oceanographer Ken Sherman. He adds that "the world's fishing nations could increase annual global yields by several million tons if they had sufficient information to practice such principles."

An LME is a broad geographic region recognizable by a generally self-contained food web and by oceanographic properties such as currents and surface temperatures. To apply the LME concept, a web of ecological and physical relationships must be understood. Scientists must determine how pollution affects all parts of the food chain, including the microorganisms at the bottom. Researchers also need to know how many individuals are needed to maintain a species and what oceanographic factors influence marine plants and animals.

However, defining the boundaries of an LME can be difficult. Ocean surface temperatures and currents vary considerably, and marine species often cross political and ecological boundaries. For example, beluga whales that migrate through Bristol Bay into the eastern Bering Sea can consume 280,000 salmon during a two-month sojourn—up to 9 percent of the annual commercial catch there.

Wave of the Future

Different LMEs pose different challenges. According to Sherman, who is chief scientist of the National Oceanic and Atmospheric Administration's Antarctic Marine Living Resources Program, that region's fishery is "custom-made" for ecosystem-perspective management. Currently, it is the only area where LME management is explicitly agreed to by the nations fishing it. In the United States, the National Maritime Fisheries Service is moving towards this approach, says Sherman. He also sees the nations fishing the North Sea beginning to use an ecosystem perspective, as is Australia for its Northwest Coast.

In 1982, the major fishing nations active in the Southern Ocean signed the convention for the Conservation of Antarctic Marine Living Resources (CAMLR). Since no CAMLR nation exercises a territorial claim in the Southern Ocean, cooperation is relatively easy. The CAMLR signatories have agreed to regulate fishing in ways that maintain all ecological relationships, and they have set up an organizational structure that decides how to obtain information, such as the distribution, abundance, and productivity of all Antarctic species, whether harvested or not. This structure also limits fishing based on the best scientific data available.

Sherman notes that member nations' individual research efforts already nearly meet the estimated $40-million-a-year cost of collecting the mandated information. These efforts are coordinated to the extent that information on the catch rates of icefish on a single day in October 1988 was sufficient to ban all fishing on the entire South Georgia continental shelf less than a month later.

In countries such as Indonesia, international agreements would be unnecessary for LME management. Under the 1982 Law of the Sea Convention, the boundaries of this archipelago nation's economic sphere, encompassing shallow and deep seas, include a recognized LME, the Banda Sea. In cooperation with the Netherlands, Indonesia is exploring the possibility of ecosytem-perspective management there, according to Sherman.

It would be more difficult to implement LME management in the Sea of Japan. While Japan and the Soviet Union have a fisheries agreement there, North and South Korea are far from even initial negotiations. In the Caribbean, a number of nations share an already overfished LME, but the region lacks the economic resources to study the ecosystem.

Despite such obstacles, international law experts see the LME framework as the wave of the future. Albany Law School professor Martin Belsky says that, "in effect, the ecosystem approach already binds the world's fishing nations." Not only does the CAMLR Convention place a priority on protecting ecosystems and endangered species, but the Law of the Sea Convention directs coastal nations to manage fisheries from an ecosystem perspective, considering the interdependency of species and avoiding over-exploiting stocks. ■

T.M. HAWLEY is assistant editor of Woods Hole Oceanographic Institution's Oceanus *magazine.*

PHOTO: BETTMANN NEWSPHOTOS

MINI · TRENDS



BIOMUSE

A new form of electronic instrument creates music from the body's electricity. Through a computer interface and small electrodes placed on the skin, the electrical signatures from muscles and nerves drive a standard music synthesizer. Thus, a musician's "inner machinery" could generate sounds, with movements or even heartbeats acting as control signals. Dancers might create music directly from the action of their muscles.

Stanford Medical School researchers Hugh Lusted and Benjamin Knapp envision that such devices could give paralysis victims the pleasures of playing music. Since any available nerve or muscle electricity can command the instruments, a disabled person might make music with eye movements.

FIRST LANDING?

The writing on a small stone relic found in a Tennessee Indian burial ground in 1889 suggests that Jews may have reached the New World as early as 70 A.D. For decades, the inscription stone was thought to be a Cherokee artifact, but in 1971 Semitic language expert Cyrus Gordon identified the writing as ancient Hebrew. His translation reads "a comet for the Jews."

Now dating the relic with accelerator mass spectrometry has shown it to be 12 to 19 centuries old, reports *Southern Exposure* magazine. J. Huston McCulloch of the Institute for the Study of American Cultures in Columbus, Ga., believes Jews fleeing a naval defeat carried the tablet to this continent. He says that during a war with Rome between 66 A.D. and 70 A.D., many Jews set out from Judea hoping to find land across the Atlantic.

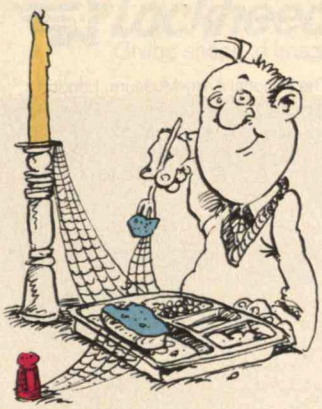
CARD CRAZE

Japanese collectors pay as much as $300 for old "telecards." The thin plastic tickets are inserted into pay phones instead of coins, and calling time is recorded on a built-in magnetic strip. Although telecards are designed to be discarded, millions of Japanese keep them for their imprints of pop music singers, scenery, children's drawings, baseball players, and nudes.

The fad started in 1984 when a subsidiary of Nippon Telegraph and Telephone (NTT) offered special-edition promotional telecards to businesses. The cards struck a chord with local boosters, and nearly every community has issued scenic tourist views. Now that Coca-Cola has adapted vending machines for similar cards, other companies are expected to issue magnetic vouchers for everything from ice cream to video games.

NTT introduced telecards because a 10-yen coin, much heavier than a dime, is difficult to lug around. Today, almost half of all calls are made with the colorful tickets, and NTT plans to market a do-it-yourself card printer soon.

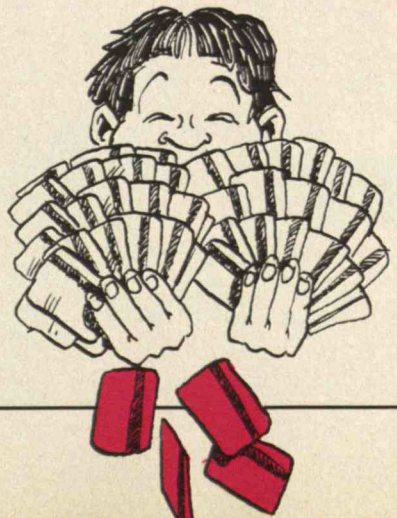
—Yoichi Clark Shimatsu/ Pacific News Service



MMM TV DINNERS

If you hunger for a tastier TV dinner, USDA's "WOF busters" have attacked this critical issue. WOF—warmed-over flavor—occurs when oxygen breaks down fats vital to fresh meaty taste. The cardboardy taste can develop when reheating uncured meats, including precooked, frozen meat in TV dinners and leftover meatloaf.

In lab tests, scientists at the USDA's Southern Regional Research Center block WOF for up to five days by adding certain proteins to ground beef. To make the additive, researchers treat chitin, a common substance from the shells of lobsters, crabs, and other shellfish.



SAFER PIPES

A National Research Council committee has concluded that long-distance pipelines are generally safe but could be safer. According to reports that federal agencies require pipeline operators to make, 10,000 failures from all causes occurred from 1971 through 1986, killing 178 people and injuring 770. Property damage totaled $300 million in 1986 dollars, and 5 million barrels of petroleum products were lost.

The committee has recommended actions by pipeline companies and federal, state, and local authorities to enhance public safety. Local measures could include improved emergency-response programs and strict prohibitions on construction along pipeline rights-of-way.

A MITE BETTER

California almond growers save $21 million each year by controlling spider-mite outbreaks with specially bred predatory mites. According to University of California entomologist Marjorie Hoy, the predators are part of a management program that saves growers $24 to $44 per acre. Hoy and an economist calculated a $384 return on every $1 invested in the research.

Spider mites became a serious problem in the late 1940s, when farmers began intensively applying chemical pesticides. Spider mites developed an ability to survive the pesticide, but most predatory mites, their natural enemies, did not. However, some predatory mites did develop resistance, explains the Berkeley researcher, and "we carried this concept the next step." By exposing predatory mites to increasing amounts of different insecticides and breeding the survivors, Hoy created stock that resists common insecticides.

ILLUSTRATIONS: JON McINTOSH

THE ZULUS AND ELECTRONIC WARFARE

In 1879 a British army under Lord Chelmsford invaded Zululand in southern Africa to claim it as Crown property. The campaign was expected to be over before the month was out.

But the Zulus proved to be no walkovers.

Among their many military talents was their use of deception. One trick was for an *impi* (the equivalent of a division) to condense its formations so the enemy could not count its regiments. Another was to have small, diversionary groups of soldiers drive herds of cattle around the countryside, raising dust and deceiving the enemy as to the location of the main Zulu force.

The Battle of Isandhlwana, Charles Fripp, 1885, The National Army Museum, London



Utilizing such deceptive tactics, the Zulus misled Chelmsford into splitting his army and taking half of it on a wild goose chase to the southeast.

Meanwhile, from the north, the main Zulu *impi* of 20,000 attacked the remainder of the English force relaxed at the base camp at Isandhlwana. The surprise was complete. The British were massacred. And Chelmsford, hearing of the disaster, retreated to Natal.

The Zulus were applying a timeless principle of warfare. Deception. A sin in everyday life, in time of war a virtue. In the late 20th century it has become essential.

Nowadays, the primary medium of this realm of warfare is electronic. Planes, tanks, ships, helicopters all have electronic means of finding the enemy or preventing him from finding them. Modern battle now, more than ever, favors the side with the most effective electronic technology.

While the Zulus used deception to help them win a battle, that tactic is now interwoven into every aspect of defense. From the movement and intentions of vast forces, down to individual encounters between aircraft or tanks, electronic deception is decisive.

But beyond this, electronic technology becomes decisive on the grand strategic level. For it is part of the deterrence that compels potential enemies to find ways to be friends.

Lockheed
Giving shape to imagination.



The Era of the Enhanced Athlete

He ran faster than any human being had ever run before—100 meters in 9.79 seconds. Yet three days after his phenomenal victory in the 1988 Olympics, Canadian sprinter Ben Johnson was officially disqualified and stripped of the gold medal. A urine sample taken after the race revealed traces of stanozolol, an anabolic steroid banned by the International Olympic Committee. Johnson was forced to leave the games, offering the implausible excuse that someone had given him a spiked drink.

During the weeks that followed, scores of moralistic newspaper and television reports seized upon the most obvious dimensions of this sad event. Johnson's sin, many concluded, was to seek unfair advantage over his fellow runners, breaking the rules of Olympic competition. His misdeed involved using a drug widely regarded by physicians and medical researchers as hazardous to human health. The lesson seemed simple: there is no place for cheats and drug abusers in sport.

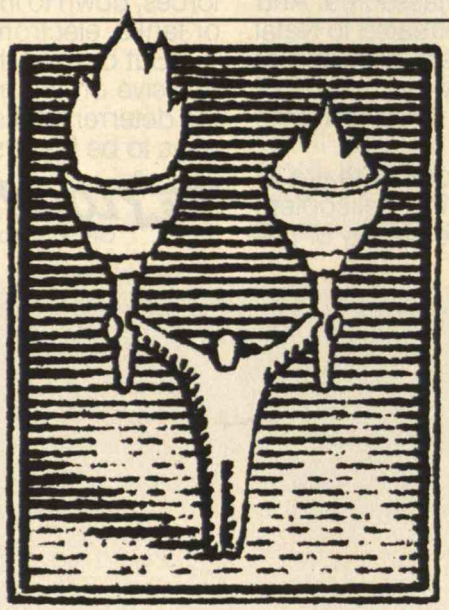
Lost in all the self-righteous commentary, however, were some larger, more disturbing questions, questions about the integrity of contemporary sports. To what extent is it legitimate for athletes to use chemicals and other advanced technologies to build bodies and enhance performance? At a time when artificial means to improve strength, stamina, speed, and dexterity are multiplying, where should we draw the line?

To a large extent, the real story of the 1988 Olympics was that of "good" sports technologies versus "bad" ones. Unfortunately, the grounds for making such judgments are not clear.

Whatever It Takes to Win

At the same time the press was bemoaning Ben Johnson's supposed crimes, it was also reporting other innovations in sports technology without criticism. Members of the U.S. volleyball team, for example, use computerized motion analysis to help them improve their jumping ability by as much as four inches. Olympic swimmers wear suits made of a special friction-reducing fabric, a breakthrough that reduces their times by precious hundredths of a second.

Or consider the range of artificial means commonly used to boost performance in competitive athletics these days: legal painkilling drugs, arthroscopic surgery, the local anesthetic Xylocaine, anti-inflammatory chemicals, scientifically prescribed diets, Gatorade, biomechanical analyses—the list goes on and on. In a society that places supreme importance on winning, athletes face strong incentives to employ the latest breakthroughs in quest of a competitive edge. As Bill Curry, football coach at the University of Alabama, commented recently, "The system is saying, 'do whatever it takes to win.' "



Criteria for telling good sports technologies from bad are unclear and unfair.

Confronted with myriad technical possibilities and intense social pressures, today's athletes face an impossible situation. The ethos of "what everyone's doing" often conflicts with the ethics of good sportsmanship.

How might these dilemmas be resolved? In the not-too-distant future, perhaps we will hold two kinds of athletic competitions. "Natural Olympics" would limit participation to athletes who do not use performance-boosting drugs and who shun all sophisticated technological aids to raw physical ability. At games of this kind we would see the human body, pure and simple, striving for excellence in a variety of challenges.

In contrast, "Enhanced Olympics" would include all those willing to take advantage of every conceivable device to boost athletic efficiency. Yes, care would have to be taken to avoid measures that were blatantly hazardous. But beyond these basic precautions, there would be no holds—no technical fixes—barred. Accomplishments like Ben Johnson's record-breaking sprint would not be scorned but rather applauded as milestones within a particular context.

This proposal may seem bizarre. But in fact, there are already sports in which distinctions of this kind have begun to emerge. Powerlifting and bodybuilding, for example, have long been the focus of controversies about whether steroids, growth hormones, and other chemicals are proper. Enthusiasts in these sports are divided over the validity of medical reports that such drugs are ineffective or dangerous, and many bodybuilders insist on using them even if it means obtaining them through dubious channels.

Unable to resolve this dispute, the various persuasions have sorted themselves into separate organizations that observe different rules. The American Drug Free Powerlifting Association and the American Natural Bodybuilding Conference strictly prohibit drug use and employ urinalysis, blood tests, and even polygraph tests to enforce compliance. Other associations remain noncommittal, tacitly condoning drug-assisted bodybuilding.

Forming separate competitions and sports federations is a solution that many will find unpalatable. But is it any worse than the practice we currently follow? Our society responds to widely felt moral ambiguities in sports by clinging to noble rules, even though they are honored more in the breach than in the observance. And instead of squarely facing the broad contradictions in current social practice, it singles out individual rule breakers, punishing them as if they were dangerous criminals.

If we cannot resolve these gnawing uncertainties about the legitimate role of technology in sports, if we cannot find alternatives to scapegoating, then perhaps we need to acknowledge our hypocrisy. At the opening ceremonies of the next Olympic games we might select a famous dignitary and, echoing the grand baseball tradition, ask him or her to cast the first stone. ■



LANGDON WINNER TEACHES IN THE PROGRAM ON SCIENCE AND TECHNOLOGY STUDIES AT RENNSELAER POLYTECHNIC INSTITUTE. HIS MOST RECENT BOOK IS THE WHALE AND THE REACTOR.

ILLUSTRATION: MARCEL DUROCHER

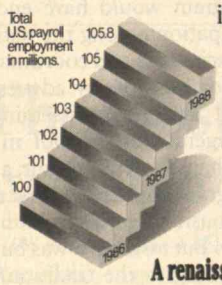
With so many things to worry about why are we so optimistic?

Those inclined to worry will always find things in the economy to worry about. But the fact is, Merrill Lynch research shows that many untapped investment opportunities are unfolding. And we believe the time to take advantage of them has arrived. Here are those trends. And what the astute investor can do about them.



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Inflation Jitters—Valid but Exaggerated Concerns

The memory of double-digit inflation in the late 1970s has a pronounced effect on financial-market behavior today. The react vigorously and harshly to any signs of incipient inflation turn, the response of the markets influences monetary polic of the yield curve, an indicator of inflation

We also see emerging opportunities in selected high-yielding stocks such as those of utilities and insurance companies. And, as Merrill Lynch Chief Investment Strategist Charles I. Clough points out, "Foreign investment flows into dollar-denominated financial assets are likely to be increasingly supportive of the U.S. financial markets."

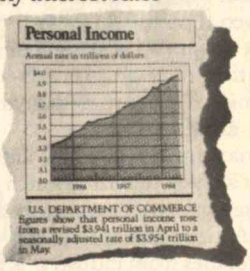
Inflation is up. But not severely.

While the drought in the Midwest is boosting food prices, the overall effect should be neither great nor long-lasting. As our Chief Economist Don Straszheim puts it, "The peak inflation rate, based on year-to-year changes in consumer prices, is likely to be about 5.5%, far below the 14.5% peak in the second quarter of 1980."

The interest rate outlook: something that should make everyone feel optimistic.

Interest rates should decline substantially in the next few years. This would be spurred by moderating inflation, slower economic growth in 1989, and a rising surplus in the Social Security trust fund, which will make the government a bigger customer for its own debt, reducing the amount it must raise from the public.

This means that U.S. Treasury bonds and high-quality corporate and municipal bonds—which are now paying healthy interest rates—are also likely to increase considerably in value.


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The Lost Opportunity in AIDS Research

In the past three years, the U.S. Government and the scientific community have missed a golden opportunity—the chance to create a coordinated national research program to counter AIDS. Part of the blame can be laid at the feet of former President Reagan, who refused to provide leadership on the AIDS issue or to demonstrate an unequivocal government commitment to research leading to effective therapy and prevention. But a good part of the blame also belongs to the scientific community and, in particular, the way we organize research.

Basic biomedical research is a classic example of "small science." It usually requires only those tools available in an individual's laboratory. And the dominant research style is to have small groups working under an individual's leadership.

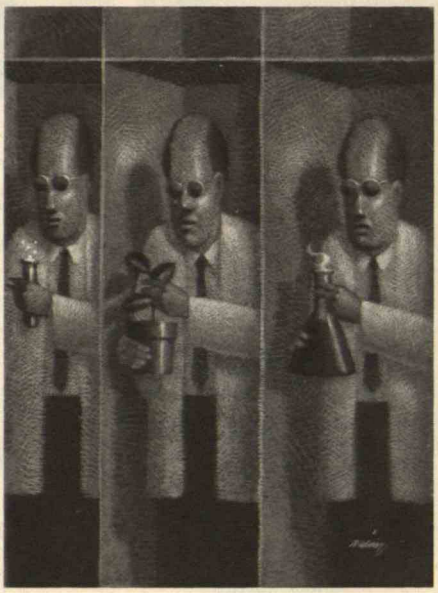
This small-science approach allows each investigator to be an independent source of scientific evaluation and insight. It is also the best way to maximize individual creativity. Those professors who allow the greatest latitude to their students and postdocs often run the most creative laboratories.

The small-science model has served modern biology well. Indeed, it is largely responsible for the extremely vibrant world of biological research in the post-World War II era. Independent, investigator-initiated research has assured that unfashionable but important topics continue to receive attention, even though their worth may not be widely evident. What's more, frequent communication through journals and conferences ensures that progress in any one area spreads rapidly to others.

But maximizing individual initiative is not the only way to organize research and, in certain situations, is not necessarily the best way either. A clear example of a different approach comes from industry. When a company decides to push the development of a product, the immediate needs of the situation determine what kind of science is necessary. Here, research is focused on particular, often mundane problems. The hotshot who gets a bright idea that is off the line of major concern will be told to file it and get back to the job at hand.



DAVID BALTIMORE is a Nobel laureate, director of the Whitehead Institute, and professor of biology at MIT. In 1985, he co-chaired a study of the U.S. response to the AIDS epidemic for the Institute of Medicine and the National Academy of Science.



The way biomedical scientists organize research is an obstacle to a coordinated national AIDS program.

Such a system is anathema to most of us who are trained at cutting-edge research institutions like MIT, and it is certainly antithetical to the ethic instilled in a young faculty member who will be judged by the originality and surprise inherent in his or her work. But in certain circumstances, the industry approach is better for producing valuable results quickly.

Fighting the Last War

AIDS research is one case where the organized research model of industry is probably more appropriate than the small-science model common in biomedical research. Three or four years ago, when the federal government began escalating the funding of AIDS research, we already had key information about the human immune deficiency virus (HIV), the virus that causes AIDS. For instance, we knew that it was a retrovirus—a well-studied class of viruses previously associated with cancer.

We also knew some of the questions to ask to spur the development of vaccines and drugs to fight HIV. What is the structure of the virus? What are the structures of the individual viral proteins? What is the function of each protein and how do the various proteins fit together to enable the virus to cause AIDS?

What's more, we knew of an analog to HIV that infected monkeys. By studying this virus in animals, we were in a position to pose many pertinent questions about how HIV causes AIDS and how its effects could be ameliorated.

Given this solid foundation, the time was ripe to bring together the relevant scientific personnel of the country—if not the world—and ask them to formulate a research program that could produce the needed answers in the shortest possible time. Such a program would have encouraged wide participation among the nation's top biomedical scientists and coordinated their activities—for example by advocating the development and wide dissemination of research reagents, a key tool in current research. Perhaps most important, a comprehensive program could have directed more funding to basic research in immunology and virology. But instead, it was business as usual, according to the traditional small-science model.

Part of the reason the National Institutes of Health didn't encourage scientists to develop a plan is that such a national program had been mounted in the recent past—only to become the object of scorn and derision in the scientific community.

When Congress and the White House declared "war" on cancer in the early 1970s, everyone who knew anything about cancer research was brought to Washington and shepherded through an excruciating and farcical process of developing a National Cancer Plan. At the time, we knew so little about how cancer comes about that a coordinated national program was wildly premature. What we really needed was small science—creative, unplanned, investigator-initiated research to answer basic questions about what is wrong in a cancer cell and what causes the lesion.

The War on Cancer did have a great impact on our understanding of the disease. But it was the funding that went to indepen-

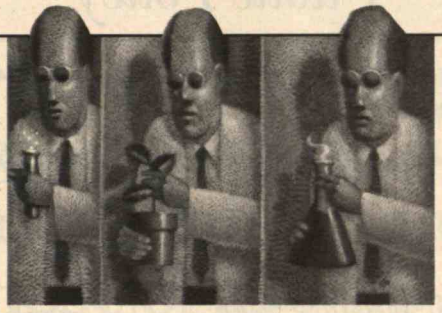
ILLUSTRATION: ROB COLVIN

dent basic research that was so effective. It led to the revolutionary discovery that cancer is caused by oncogenes and hastened the development of the recombinant DNA methods that have produced modern biotechonlogy. Such discoveries happened in spite of the National Cancer Plan, not because of it.

The experience of the War on Cancer made terms like "organization," "plan," and even "coordination" dirty words to biomedical researchers. Thus, when AIDS hit, many scientists acted like generals fighting the last war. They urged that we not repeat the mistakes of the past—overlooking the key differences between the amorphous state of cancer research in 1970 and the relatively well defined questions facing AIDS researchers in 1985.

Patchwork Quilt

As a result, NIH created a patchwork quilt of AIDS-related research programs with no central coordination. Many scientists, myself included, are participating in these programs, and we are collecting much exciting information. But the response is neither adequate to the problem nor worthy of the scientific community. To this day, our efforts lack the involvement of key scientists and a publicly stated and clearly defined set of priorities and goals.



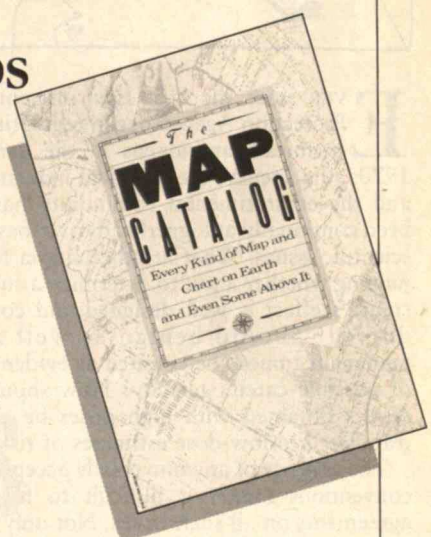
The fundamental problem is that small science does not lend itself to mobilizing a systematic response to a specific problem. By definition, each research project submitted for funding reflects only one person's view of an appropriate scientific goal, without concern for the needs of a larger project, the needs of society, or other programs that might be proposed by other investigators. The most that NIH can do to guide this creative chaos is to advertise needed research directions and set money aside for them. This can provide better coverage of relevant areas of research on a particular disease, but it does not guarantee that those with the greatest talents and skills will put their intellectual strength to work on the key problems.

Today, the time for a unified approach to AIDS is probably past. We already have so many programs in place that it would be hard to reshape them into one coordinated effort. Better to dedicate ourselves to the fastest possible progress within the present organizational framework.

But the next time nature sends a health threat as severe as AIDS, we biomedical researchers should not be so quick to reject the idea of a concerted program. ■

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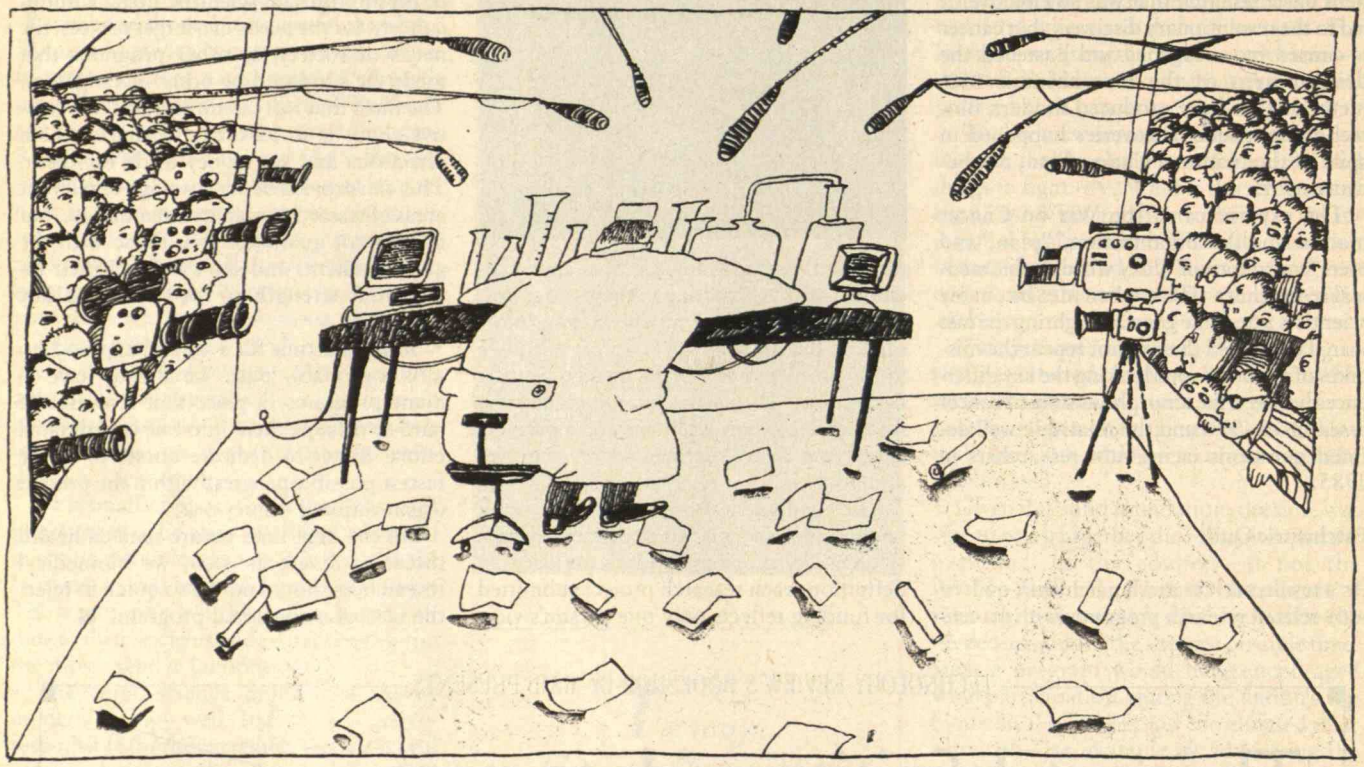
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BY SHEILA JASANOFF

Public Science for Public Policy



EVER since the U.S. Environmental Protection Agency began regulating chemical carcinogens in the early 1970s, the agency, the chemical industry, and the environmental community have been continually at loggerheads over basic scientific issues. What are the criteria for judging whether a test to determine a substance's effect is well designed and conducted? Should benign as well as malignant tumors be counted as evidence of possible carcinogenicity? How should results obtained with high doses be extrapolated to low-dose estimates of risk?

The absence of any universally accepted conventions makes it difficult to forge agreements on all such issues. Not only is the science uncertain, but different answers carry major economic and political consequences.

This often leads to litigation. But lawsuits aren't always the best solution. The polarized processes of the courtroom damage the credibility of experts and destroy the possibility of consensus, without providing any guarantee of truth.

Scrutiny of agency research by an informed public can uncover weaknesses that experts don't detect.

To escape demoralizing debates over scientific uncertainties, federal agencies have started experimenting with several novel approaches. Applied to many kinds of health and environmental decisions, these approaches are designed to maintain scientific integrity while reducing conflict. Generally, these processes seek to involve a wider set of interests in generating and interpretating technical information, thereby creating a scientific base relatively invulnerable to political challenge.

None of the processes can be regarded as a panacea, but each can supplement more traditional mechanisms of ensuring accuracy, such as replicating experiments and conducting peer review. As the federal government is starting to discover, in a democratic society the scientific basis for policy decisions must be genuinely rooted in participatory involvement.

Fear Among Residents

The Love Canal controversy of 1980 provided a major incentive for agencies to rethink their approaches to scientific decision making. EPA had sponsored a study of chromosome damage among Love Canal residents as evidence for its pending lawsuits against Hooker Chemical Co. Initial agency research claiming that there were extensive chromosomal aberrations in a study group was leaked to the press before undergoing peer review. The leak aroused enormous fear and anguish among area residents.

Two teams of independent reviewers eventually dismissed the study as scientifically unsound. They concluded that the study design should have been examined

Continued on page 28

SHEILA JASANOFF directs Cornell University's Program on Science, Technology, and Society, and is finishing a book on public science to be published by Harvard University Press in 1990.

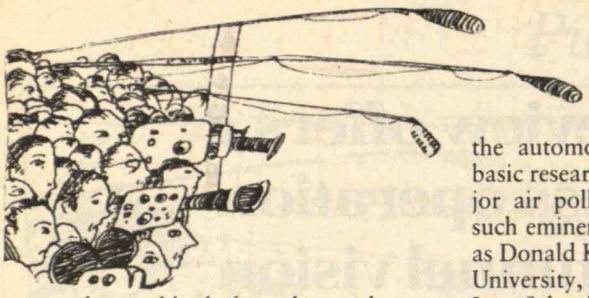
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more thoroughly before the study was undertaken.

However, the peer-review panels failed to establish their own scientific credibility to the public's satisfaction. Love Canal residents particularly criticized the report of the peer-review panel chaired by Lewis Thomas, then chancellor of Memorial Sloan-Kettering Hospital of New York City. With some justification, the residents argued that the report contained scientifically unsupported statements and that it had not undergone formal public review.

In a later study of the habitability of the Love Canal region, EPA and three other agencies, the Centers for Disease Control and the New York departments of environmental conservation and of health, were much more attentive to the need to involve the public. The four-agency committee responsible for the investigation met in locations convenient to the Love Canal community. When the committee convened a scientific advisory panel to develop criteria for resettling the polluted area, residents were permitted to suggest members and to question the experts. Another body of scientists who reviewed the draft report also conducted their deliberations in public. The openness of this procedure reassured the skeptical Love Canal community that the habitability study did not reflect the hidden biases of any interest group.

It would be a mistake to conclude that public participation in such a process is merely a political expedient. Scrutiny by an informed public can uncover technical weaknesses that neither the experts nor specialist reviewers detect. For example, after the National Cancer Institute published in 1986 an epidemiological study of workers exposed to the chemical formaldehyde, independent analysts pointed out that the research did not examine enough workers to be able to establish with statistical certainty whether the substance was a carcinogen.

Another intriguing attempt to create a cooperative framework for conducting science has been the development of the Health Effects Institute (HEI) in Cambridge, Mass. Jointly funded by EPA and the automobile industry, HEI sponsors basic research on the health effects of major air pollutants. Its board consists of such eminent scientists and public figures as Donald Kennedy, president of Stanford University, and Archibald Cox of Harvard Law School.

HEI has to convince skeptical experts from both EPA and industry that its methods are scientifically sound. Therefore, the institute employs a number of safeguards to eliminate the possible biases of any expert group. One panel of scientists—chosen by HEI's board—reviews proposals from outside researchers; another chosen in the same way reviews completed studies. The institute also takes pains to ensure that the traditional scientific monitoring processes function effectively: Study design is viewed as integral to maintaining quality. And independent quality-assurance experts police the research as it is being conducted to make sure that each step conforms to the original design.

The organization's strengths have prompted EPA to turn to HEI when its own studies are questioned. For example, in March 1983 EPA was about to propose a revised air-quality standard for carbon monoxide when it learned that Wilbert Aronow, a cardiologist who had performed seven of eight key studies underlying the proposed standard, was suspected of falsifying data. A carbon-monoxide study designed and carried out at several universities under HEI's auspices confirmed Aronow's findings that even low concentrations of carbon monoxide can harm patients with heart disease. In addition to examination at HEI, the results were reviewed by a panel of outside experts and discussed at an open scientific meeting in April 1988.

Critiquing Agency Studies

Regulatory peer review has become another popular mechanism for involving outsiders in scientific work conducted by federal agencies. This practice, in which boards of outside scientists examine agency studies, started in the mid-1970s in response to public demand. Today Congress requires EPA, the Food and Drug Administration (FDA), the Consumer Products Safety Commission, and the Agency for Toxic Substances and Disease Registry to use such boards for help in deciding whether certain regulations make scientific sense.

Nominations for major regulatory peer-review bodies are publicly solicited. In the case of the Science Advisory Board at EPA, the agency's administrator then makes the final selection after consulting with the board's executive director. Regulatory peer-review panels generally include a wider range of disciplines and political perspectives than their counterparts in the research setting. Federal law also requires such bodies to hold their meetings in public. And their findings become part of the agency's open policymaking record.

Experience with the advisory panels attached to EPA and the Food and Drug Administration suggests that such groups can help agencies overcome political biases and scientific tunnel vision. For example, EPA's Office of Toxic Substances tentatively decided in February 1982 not to consider formaldehyde a high priority for regulation, although animal studies reliably indicated that the substance was a carcinogen. John Todhunter, then assistant administrator for pesticides and toxic substances, justified this decision in a technical memorandum that seemed to fly in the face of principles that EPA had previously used in assessing carcinogenic chemicals.

Under fire from public-interest groups, members of Congress, and scientists, EPA in 1983 reversed its decision and decided to re-analyze formaldehyde. While the agency legally did not have to subject its new assessment to regulatory peer review, EPA consulted with the Science Advisory Board. The board recommended that EPA look more critically at how the compound reacts with the human body. As a result, the agency improved the science in its risk assessment for formaldehyde. Subsequently, however, EPA decided that formaldehyde is mainly a problem of the workplace, the province of the Occupational Safety and Health Administration.

Hearing More Perspectives

The new processes suggest that decision makers are becoming sensitive to the need to incorporate more viewpoints in the science underlying public policy.

Of course, agency officials have to consider the costs of these processes carefully. All three models described are expensive. HEI's carbon-monoxide study, for ex-

Continued on page 78

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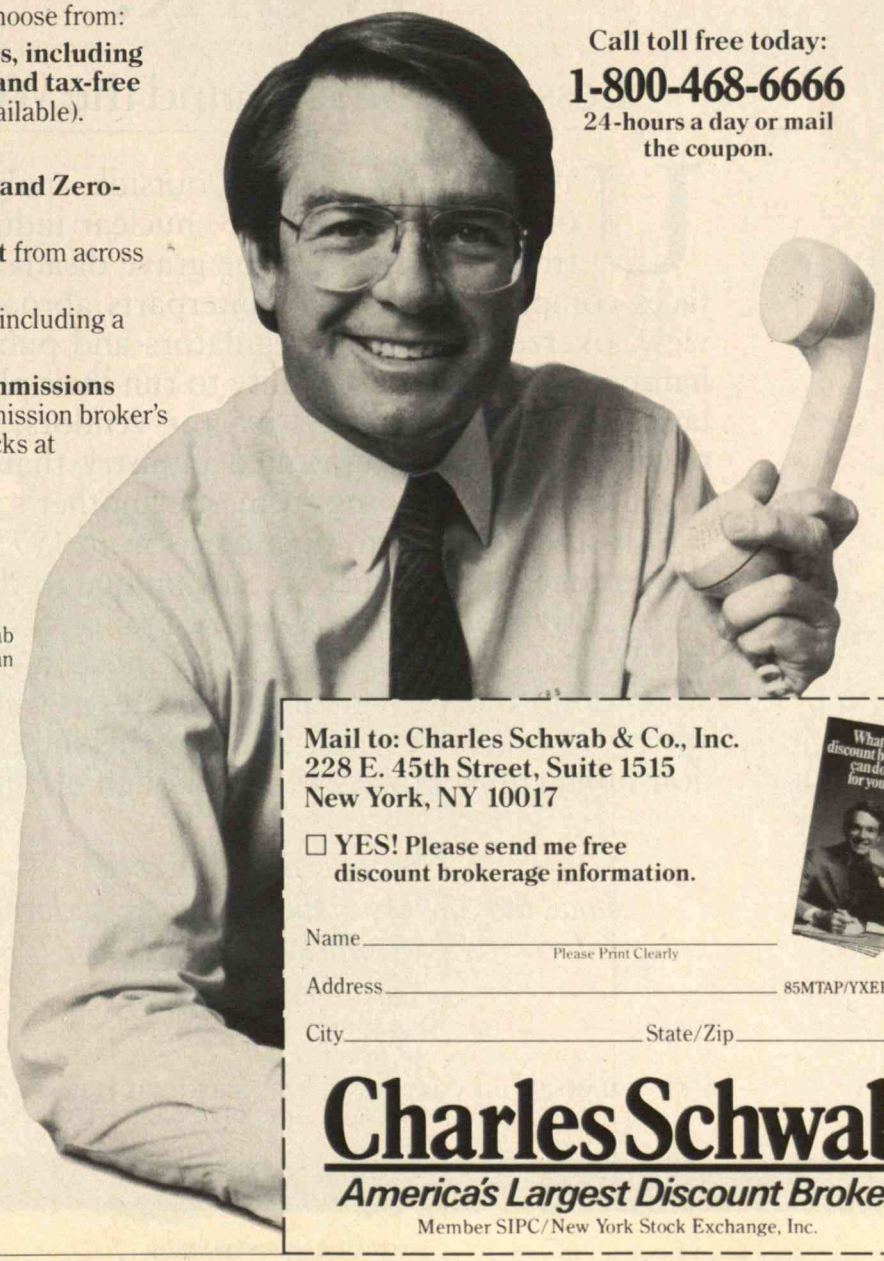
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Making Nuclear Power Work:

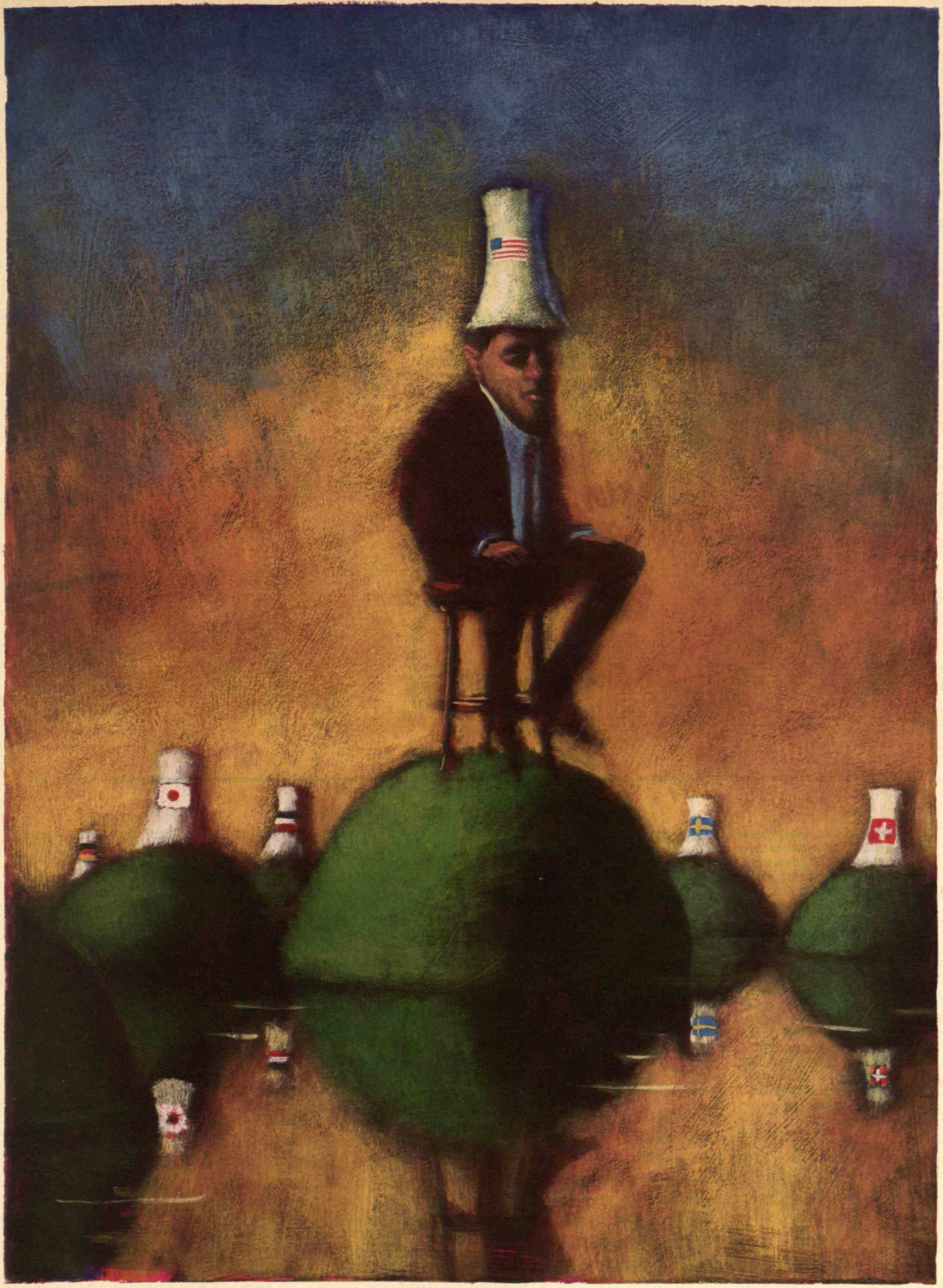
Lessons from Around the World

UTILITY managers and outside analysts alike often say that the U.S. nuclear industry is in trouble because of the grave disadvantages it faces compared with its counterparts abroad. In this view, overzealous safety regulators and public critics hamper U.S. managers' ability to run their plants. The large number of utilities, reactor vendors, and suppliers results in a fragmented industry that prevents operators from learning from one another's mistakes.

Our study of nuclear operations from 1975 to 1984 shows that these factors are not unique to the United States. Utilities in Japan, Sweden, France, Switzerland, and West Germany outperformed those in the United States despite strict regulatory climates as well as great variety in reactor design, utility ownership, and relationships with suppliers. And although public opinion

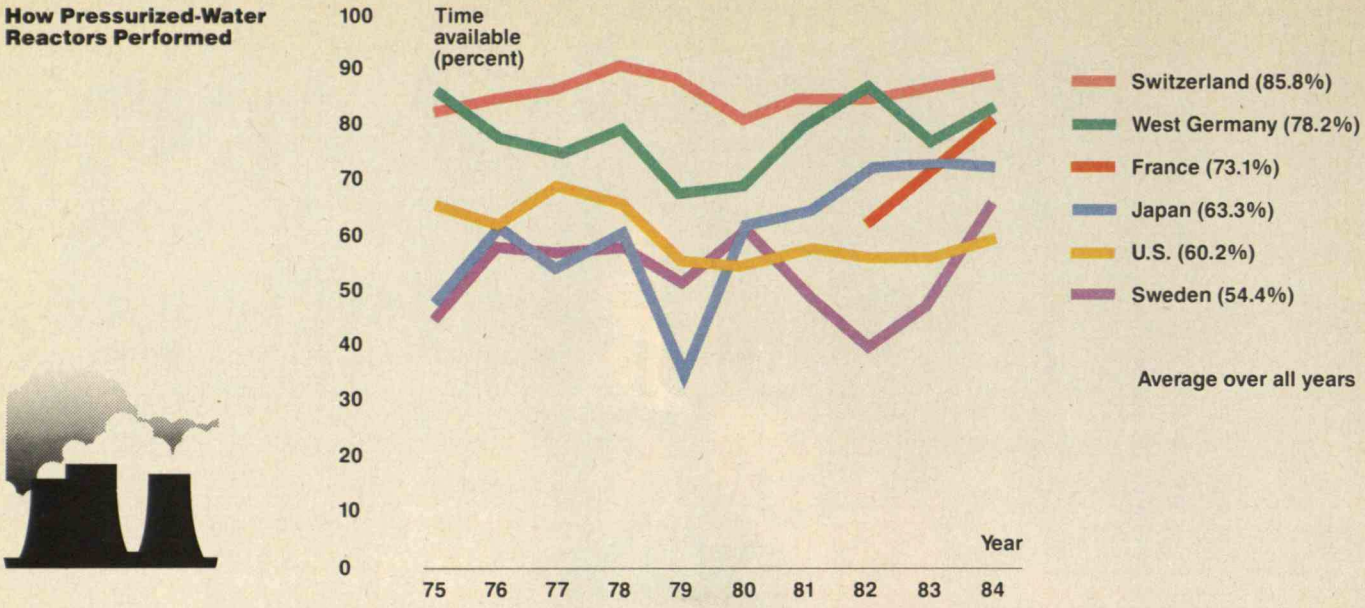
An international study shows that the key to improving the performance of U.S. nuclear plants lies in managerial reform.

BY KENT HANSEN, DIETMAR WINJE, ERIC BECKJORD, ELIAS P. GYFTOPOULOS, MICHAEL GOLAY, AND RICHARD LESTER



ILLUSTRATIONS: KEVIN HAWKES

How Pressurized-Water Reactors Performed



	SWITZERLAND			WEST GERMANY			FRANCE			JAPAN			SWEDEN			UNITED STATES		
	% Avail.	σ	Plants	% Avail.	σ	Plants	% Avail.	σ	Plants	% Avail.	σ	Plants	% Avail.	σ	Plants	% Avail.	σ	Plants
1975	82.5	0.8	2	85.9	3.3	3				47.5	36.3	4	45.2		1	66.4	13.2	27
1976	84.9	1.7	2	77.8	16.4	4				62.1	12.5	5	58.4		1	62.3	15.0	30
1977	86.5	1.5	2	75.4	10.4	5				54.9	28.3	6	57.3		1	69.6	10.4	36
1978	90.2	0.1	2	79.2	8.2	5		N/A		60.7	10.3	6	58.4		1	67.0	16.8	39
1979	87.7	0.7	2	68.1	13.1	6				34.5	15.7	8	51.6		1	56.3	20.9	40
1980	81.1	5.6	3	69.5	13.7	6				62.4	15.4	8	61.3		1	55.0	20.8	41
1981	85.3	4.0	3	80.0	5.2	6				64.3	17.9	9	49.8	14.9	2	58.0	21.3	46
1982	84.7	3.5	3	86.8	4.6	7	63.1	20.1	19	72.8	13.2	10	40.3	24.6	2	56.6	22.0	47
1983	87.1	3.2	3	77.4	9.4	7	72.4	11.1	19	73.6	17.3	10	48.5	11.5	3	56.8	23.6	49
1984	89.0	0.2	3	83.1	6.8	7	81.6	7.3	24	72.9	12.9	11	67.0	6.3	3	60.2	23.4	52

Many countries have had difficulties with their pressurized-water reactors, but most have improved their records. The exception is the U.S., whose overall performance has remained poor. The charts show what percentage of time the average reactor in each country was available to produce power. The middle column shows the standard deviation, or spread of results about the average, among each nation's plants. The U.S. also compares badly using this measure of consistency.

can affect the overall climate for nuclear power, public opposition is not unique to the United States and did not influence reactor performance during the decade of our study.

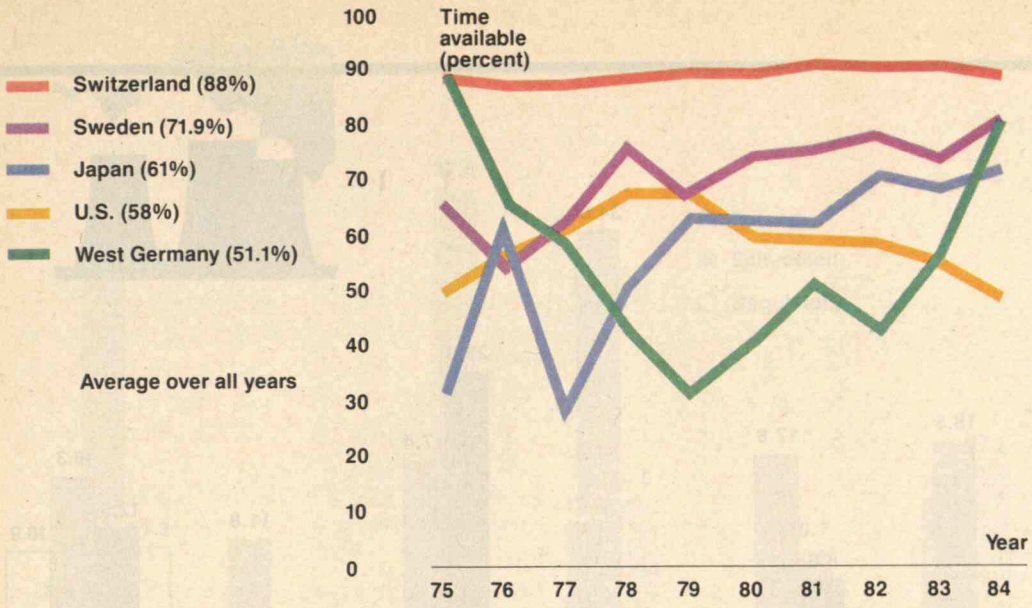
We found that the best U.S. reactors performed as well as any of their counterparts abroad. But the worst did significantly worse, dragging down the overall average performance of the U.S. industry. Moreover, many other countries experienced difficulties with their reactors and were able to turn their records around.

These findings suggest that the key to improving the U.S. nuclear industry lies not in changing the system within which utilities operate, but rather in implementing managerial reforms that have proven crucial to success elsewhere.

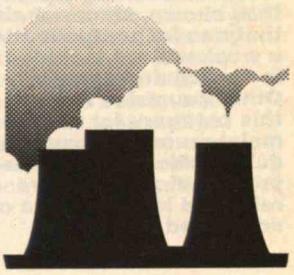
To better understand the roots of the U.S. industry's problems, we compared reactor performance in six nations with major nuclear programs. We analyzed figures provided by national organizations in each country and interviewed members: utility managers and operators, suppliers, and regulators.

Our study included every light-water reactor—the world's dominant nuclear technology, one that uses

KENT HANSEN, ELIAS P. GYFTOPOULOS, MICHAEL GOLAY, and RICHARD LESTER are members of MIT's Nuclear Engineering Department and Energy Laboratory. DIETMAR WINJE is a professor at the Technische Universität Berlin. ERIC BECKJORD, now director of research at the U.S. Nuclear Regulatory Commission, participated in the study on which this article is based while a visiting professor at MIT. The authors' results are part of a long-term program at the Energy Laboratory's Center for Energy Policy Research dealing with issues in the international nuclear power industry.



How Boiling-Water Reactors Performed



	SWITZERLAND			SWEDEN			WEST GERMANY			JAPAN			UNITED STATES		
	% Avail.	σ	Plants	% Avail.	σ	Plants	% Avail.	σ	Plants	% Avail.	σ	Plants	% Avail.	σ	Plants
1975	86.9		1	64.7	4.9	2	88.7		1	28.1	33.0	3	49.4	17.7	18
1976	85.9		1	53.0	12.9	4	65.4		1	61.9	13.6	5	55.4	17.6	19
1977	86.3		1	61.2	7.4	4	75.3	7.8	2	25.8	21.5	5	60.1	12.9	21
1978	87.3		1	74.8	6.2	5	41.7	7.0	2	49.7	26.7	9	67.5	12.5	21
1979	88.0		1	66.0	12.6	5	30.1	28.7	3	62.5	9.6	10	67.1	14.7	22
1980	87.9		1	73.6	6.3	5	39.2	23.6	4	61.7	12.3	10	59.2	13.0	22
1981	89.5		1	75.0	6.3	7	50.0	21.0	4	61.4	13.6	10	58.7	14.2	22
1982	89.9		1	77.7	8.5	7	41.9	19.4	4	70.2	14.5	11	58.5	19.0	22
1983	90.1		1	73.1	10.3	7	56.4	28.0	4	68.2	8.1	11	54.8	21.3	23
1984	88.5		1	80.9	5.1	7	78.8	3.6	4	72.1	13.8	13	48.3	26.1	25

ordinary water for cooling—of at least 300 megawatts operating from 1975 to 1984 in these countries. The plants come in two versions: pressurized-water reactors (PWRs) and boiling water reactors (BWRs). What we found was a remarkable variation in performance. Different countries achieved different results with the two kinds of reactors, and these results changed over time.

Reactor designers originally expected that nuclear plants would be easy to operate, and that they would therefore be used almost continuously at full power. This was considered important because the capital cost of nuclear power is high. Both reactor designers and utility managers realized the need to close a plant for refueling, and they planned six weeks per year for this process plus maintenance. Thus, they expected that a plant would operate at full power for about 88 percent of the year.

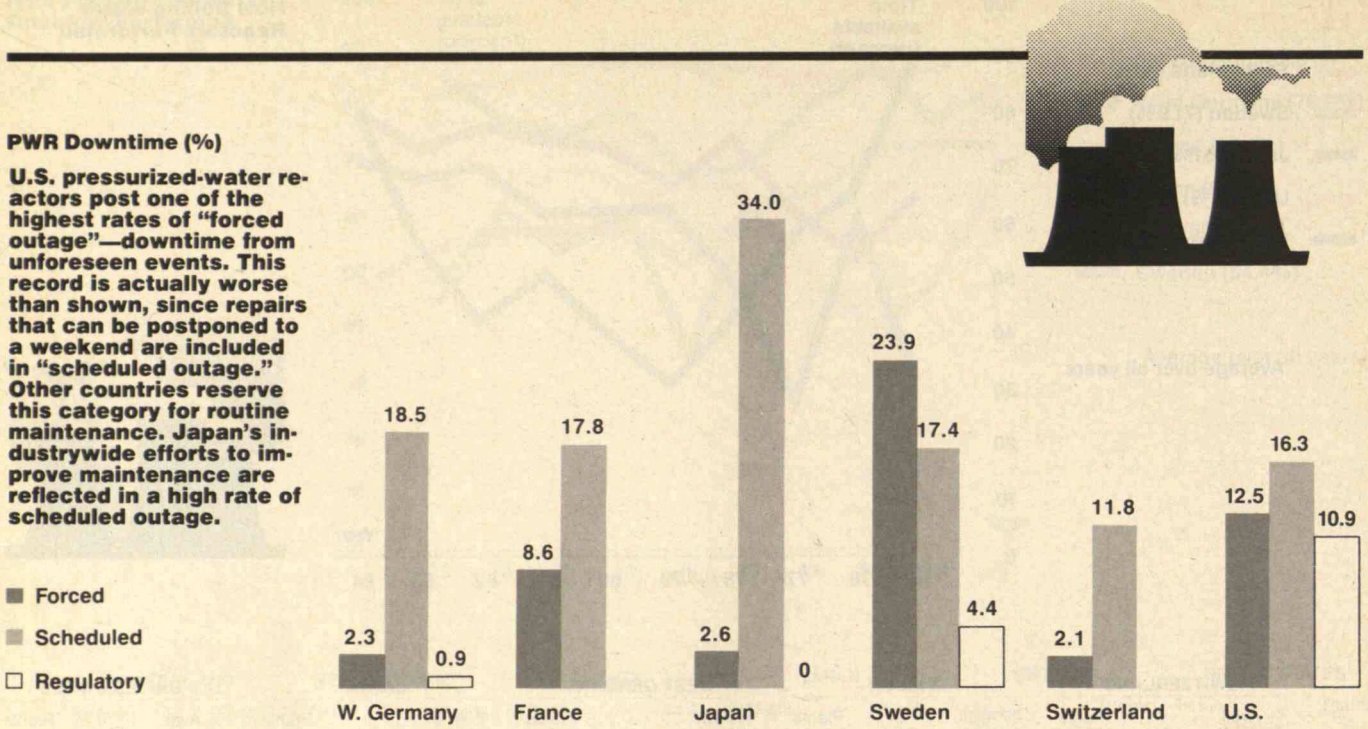
Our study reveals that pressurized-water reactors in only one country—Switzerland—came close to this goal, recording "energy availability" levels of more than 80 percent over 10 years. (Availability measures how much power reactors actually *can* produce as opposed to the amount they *do* produce, since some plants may be on line but not in use.) The Swiss, who operate only 3 PWRs (*see the charts on this page*), are also the most consistent performers, with the difference between their best and worst plants averaging only 8 percentage points during the time of the study. This small difference year after year suggests that all the plants

Results for boiling-water reactors vary, with Switzerland again posting the best record. Japan revamped its preventive-maintenance plan for all reactors to improve its record. The United States, with as many reactors as the other nations combined, shows a downward trend. (France has no reactors of this type.)

DIAGRAMS: TOM BRIGGS DESIGN

PWR Downtime (%)

U.S. pressurized-water reactors post one of the highest rates of "forced outage"—downtime from unforeseen events. This record is actually worse than shown, since repairs that can be postponed to a weekend are included in "scheduled outage." Other countries reserve this category for routine maintenance. Japan's industrywide efforts to improve maintenance are reflected in a high rate of scheduled outage.



are well designed, built, operated, and maintained.

West German PWRs also performed well. Reactor ratings in that country declined to under 70 percent in the late 1970s, when utilities decided to strengthen safety systems across the board. After completing these upgrades, the industry boosted energy availability above 80 percent and shrank the difference between the best and worst PWRs from a high of 16 percentage points in 1976 to just under 7 percentage points in 1984.

Japan has posted the most dramatic improvement. Pressurized-water reactors there posted an energy availability of only 35 percent in 1979. In response, the entire industry—utilities, vendors, engineering firms, and government—developed a plan for improving preventive maintenance. This policy paid off in consistently good performance, with energy availability averaging more than 70 percent in the early 80s. The Japanese appear to have continued their improving trend over the past five years.

Sweden, which ran only two PWRs, averaged a low 55 percent availability over 10 years. Problems with steam generators, which other countries also experienced, meant that much of its nuclear capacity was shut down at any given time.

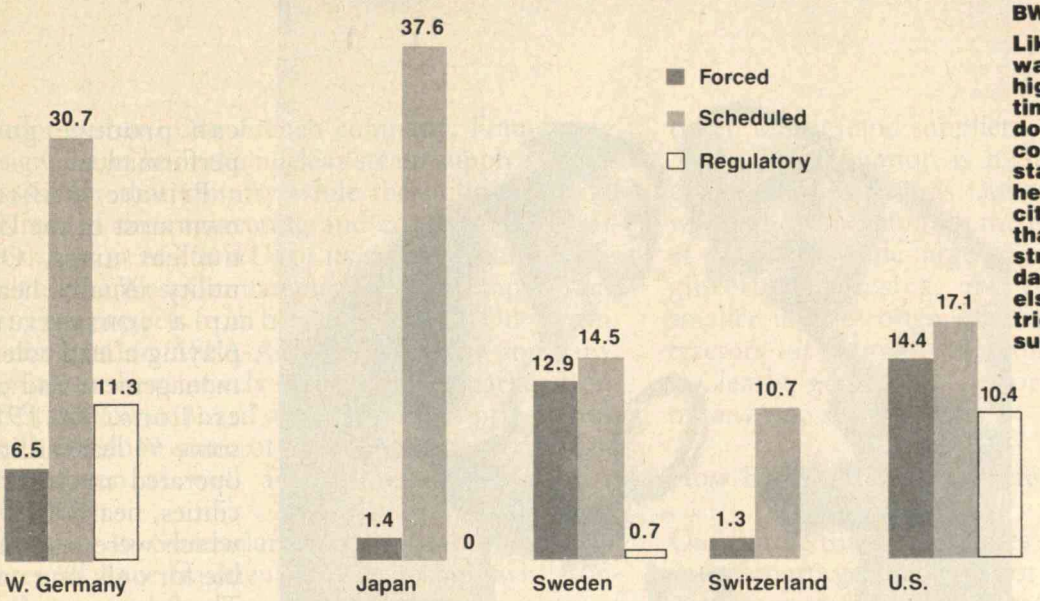
The most striking aspect of the U.S. industry—which had as many pressurized-water reactors (over 50) as the other nations combined—was its great variation in performance. Some plants performed as well as the Swiss plants year after year, others fluctuated from excellent to poor and vice-versa, and some performed consistently badly. Some 6 plants on line for at least 10 years posted a lifetime availability of over 75 percent, while 6 other plants with similar experience functioned in the 40 percent range. Overall U.S. PWRs posted a relatively poor record, averaging only 60 percent energy availability in 1984—the worst of any of the six nations that year. And unlike reactors in the other countries, U.S. nuclear plants did not show an improving trend during the early 80s. This record does not appear to have improved during the past few years.

Results for boiling-water reactors also varied from country to country (*see the charts on page 33*), with Switzerland again achieving the most outstanding results. Sweden's BWRs showed a steadily improving performance second only to Switzerland's. The Germans, in contrast, had more trouble with this type of reactor than with their PWRs.

As with pressurized-water reactors, the U.S. utilities ran over half of the world's boiling-water reactors but posted the weakest energy availability—as low as 50 percent in 1984. Performance showed a general downward trend during the decade.

Regulatory Zeal

Despite complaints by the U.S. industry about the excess zeal of safety regulators, we found that this factor can account for only a small fraction of the poor U.S. performance. Strict safety standards are not unique to the United States. All six countries maintain an independent agency much like the U.S. Nuclear Regulatory Commission (NRC) to set op-



BWR Downtime (%)

Like PWRs, U.S. boiling-water reactors post a high rate of forced downtime. "Regulatory" shutdowns, which result from complying with safety standards, are also high here. The U.S. industry cites this as evidence that regulators are too strict. But safety standards are just as tight elsewhere. Other countries usually consider such shutdowns "forced."

erating guidelines—known as "tech specs," or technical specifications. Tech specs determine, for example, how much radioactive water can leak from a reactor's primary cooling loop to its secondary loop before a plant must shut down. Regulators in all six countries have unambiguous authority to require utilities to close their reactors if they violate tech specs.

What is unique to the United States is a highly antagonistic relationship between regulators and utilities. Many industry people think NRC staff members are technically inept or promoting a hidden agenda. Conversely, regulators often believe that utilities managers are less than forthright in responding to requests and orders, and that some do not make safety a priority. Both regulators and utility managers deplore members of Congress who second-guess every decision, usually garnering a great deal of media attention, and lament a legal process that permits indefinite delay in attempts obtain an operating license.

In other countries, relationships between regulators and utilities may become strained at times, but all parties report that communication is open and forthright, with no group withholding information or acting secretively or vindictively. Regulators do not usually need to prove their strength and independence, and they analyze differences of opinion carefully before taking strong action. Nor do politicians attempt to interfere in regulatory decisions. And the public generally considers regulators responsible and competent, and so makes little attempt—and has little opportunity—to intercede on the grounds that regulators are failing to represent the public interest.

U.S. regulators do occasionally take actions that their counterparts abroad would not. For example, the NRC ordered five plants shut down for several months around the time of the Three Mile Island accident because of concern that some pipes could not withstand serious earthquakes. Later analyses showed the concern was invalid, and the NRC admitted that the shutdown had been unnecessary.

This problem would undoubtedly have been treated differently in other countries. However, we did not find such instances common. Nor did we find that public opinion—another supposed bane of the U.S. industry's existence—affected reactor performance, either in the United States or abroad. The average citizen has little opportunity to intervene after a nuclear plant has begun operating.

U.S. utilities did post one of the highest rates of "outage" caused by safety regulators, losing an average of 10 percentage points of capacity per year. (*See the charts on these pages.*) But these figures may overstate the problem, since they include violations of tech specs.

Other nations define this category differently. They see violations of tech specs as cases where good engineering practice means plants *should* close, and therefore report them as "forced shutdowns"—the category reserved for unforeseen events. France and Switzerland do not even recognize the concept of regulatory loss. In West Germany and Sweden, shut-

downs are considered regulatory only when a utility and a regulator do not agree on the need for it.

Not surprisingly, given the overall success of their nuclear programs, Switzerland, Japan, and West Germany show low rates of forced outage—an average 2.5 percentage points of their total PWR capacity per year. The French lost an average of 9 percentage points of capacity annually to forced outage but showed an improving trend in the early 1980s. Sweden's disappointing 24 percent figure for PWRs reflects its problems with steam generators; the country does better with BWRs.

The U.S. industry averages a high rate of forced outage—13 percentage points for PWRs and 15 percentage points for BWRs, and these figures have been high from the beginning of the nuclear program. But the problem may be even worse, since the industry calls repairs that can be postponed to the next weekend "scheduled outages"—the label other countries reserve for plant refueling and maintenance.



One hurdle U.S. utilities face that their overseas counterparts do not is heavy financial scrutiny from state and local regulators.

How Ownership Affects Results

A look at the ownership patterns in different countries reveals that the U.S. nuclear industry does not operate in a uniquely fragmented atmosphere. Some other countries achieve success with almost equally diffuse structures. And different ownership patterns can produce good performance.

Private utilities own most of the U.S. nuclear units. One utility usually heads up a consortium, playing a lead role in management and operations. In 1986 some 54 lead utilities operated nuclear facilities, nearly half of which were responsible for only one unit. The 3 largest utilities of this group—Tennessee Valley Authority, Commonwealth Edison of Chicago, and Duke Power Co.—operated 25 percent of U.S. nuclear capacity.

The Swiss have achieved their impressive record with a diverse system in which four large private utilities own the country's nuclear plants. In Japan, nine private utilities own all the nuclear units. But France has achieved its excellent results with Electricité de France (EDF), a monolithic utility owned by the government.

Swedish ownership of nuclear capacity divides about evenly between public and private utilities, with some municipal and cooperative utilities owning stock in the privately run companies. Similarly, nine large private utilities own most of the nuclear plants in West Germany, although public authorities may hold stock in them.

The relationship of outside contractors to utilities also varies widely among the countries, with no one setup guaranteeing or ruling out success. For example, three countries—France, West Germany, and Sweden—achieved different results using a simple

vendor system. One French company, Framatome, designed and built the nuclear steam supply systems (NSSSs) for that country while the utility itself did the rest of the engineering and construction. Kraftwerk Union AG (KWU) or its parent organizations built all the West German plants in our sample, managing the projects from beginning to end. One steam-system vendor, ASEA-ATOM, a Swedish company, dominates the relatively small Swedish market. Both the State Power Board and the various private utilities have done some of their own engineering and construction as well as contracting with ASEA-ATOM.

Utilities in Switzerland, Japan, and the United States all have fragmented relationships with contractors yet produce much different results. None of the three NSSS vendors in Switzerland are Swiss, and a variety of indigenous and foreign suppliers provide engineering and construction services and other major components. In Japan, three companies, part of the industrial consortia Mitsubishi, Hitachi, and Toshiba, provide the NSSS as well as other components and design. Various firms provide engineering and construction services. In the United States, four vendors supply the NSSS. Engineering and construction arrangements span the entire spectrum from, on one extreme, nine firms providing design work to, on the other, eight utilities managing their own construction programs.

Finally, the internal organizations of the utilities themselves vary widely. The depth and breadth of competence within France's monolithic EDF is great, and the central organization makes for ease of communication. The French practice of typically siting four plants at each site also aids in sharing experience and simplifying planning. Typically 900 people operate the plants at each site while more than 700 staff members plan maintenance and refueling from Paris.

Hundreds of employees at the German, Swedish, and Swiss sites not only run the plants but also plan downtime for maintenance and repairs. Headquarters exert relatively little control. Instead, one employee, the site manager, maintains full responsibility and authority for keeping reactors running smoothly and safely. Conversely, the Japanese tend to maintain relatively small utility staffs, relying on contractors for services and supervision. This system reflects the long-lasting relationships between utilities and suppliers.

The U.S. situation is highly varied. Large integrated utilities such as Duke Power and Commonwealth Edison maintain their own operations staffs at the plants while large central staffs deal with engineering, licensing, and planned outages. The smaller utilities often rely heavily on outside contractors for many of these functions.

Clearly, good plant performance does not hinge on any one system.

How Economics Affect Performance

One hurdle that U.S. utilities face and their overseas counterparts generally do not is heavy financial scrutiny from state and local regulators. The oil price shocks of the 1970s had a profound effect on the attitudes of state public utility commissions, or PUCs, which set electricity rates. Today these commissions are under great pressure to keep rates low. They are therefore delving deeper and deeper into utility decision making, questioning the prudency of plant costs and sometimes removing large amounts of money from calculations used to determine rates. The commissions have also begun to look at plant operations as a potential source of inefficiency and excess cost.

However, we found little evidence that such economic regulation influenced plant performance during the time of the study. This could change as more and more U.S. regulators encourage utilities to pursue "least-cost planning," forcing them to trade long-range performance for short-term savings. If it continues, we believe least-cost planning will prove uneconomical.

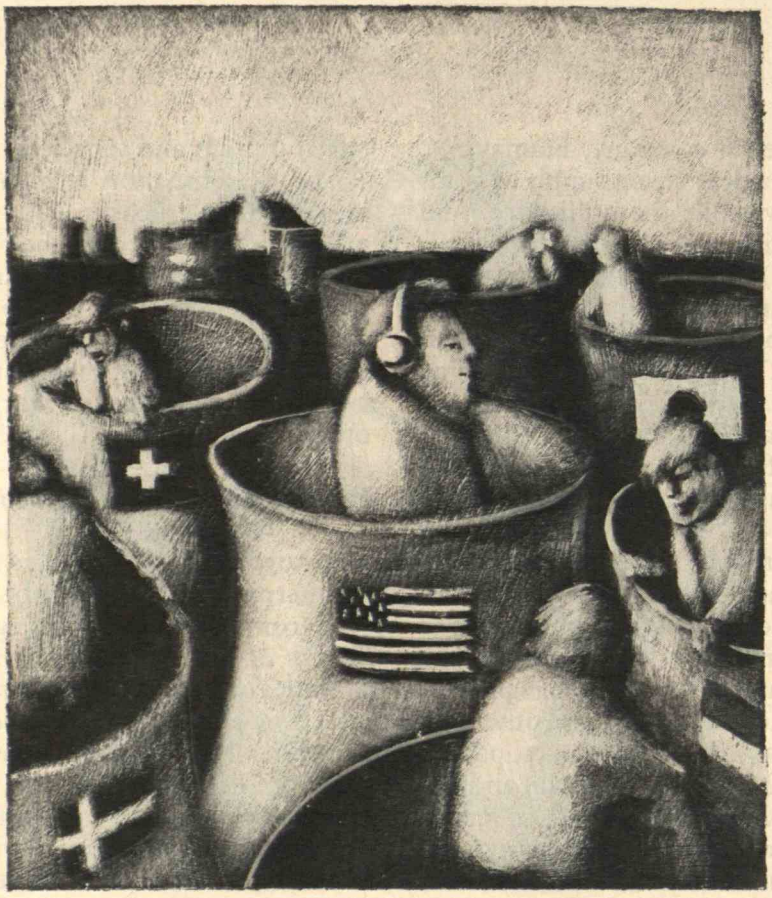
Individual plants abroad do not face such economic review, largely because nuclear power is often much cheaper than electricity from fossil fuel. Consumers have long been used to paying high prices for electricity, and authorities set rates for nuclear power that give utilities a good return on their investment.

In France, the government actually makes money for the national treasury from electricity rates. MITI sets electric rates in Japan such that utilities have not had trouble funding new plants or avoiding financial distress. In West Germany, state authorities establish electricity rates based on overall cost to residential and small commercial users, not on the

records of individual plants. In Switzerland, local distribution companies buy their electricity from the large suppliers at unregulated prices.

Sweden is the exception to this general rule. Hydropower is much less expensive than nuclear power there, but water supplies vary from year to year. When water is plentiful, the State Power Board sets low electric rates, and private nuclear utilities lose money. When water is scarce, rates go up and nuclear becomes economical.

The cost of electricity from nuclear power versus fossil fuel may help explain the performance gap between U.S. and foreign utilities. This is because the cost of power affects the amount of money utilities can invest in their plants. Owners abroad who spend a lot on the initial plant design will still have an economical source of electricity. U.S. owners, facing close competition from coal, may try to limit their capital investment. Such short-term savings may translate into long-term problems. Unfortunately, since each country keeps track of plant costs differently, we were unable to compare them on a common basis.



Nuclear experts abroad are baffled by the late start the U.S. utility industry has made in exchanging information, improving equipment, and criticizing itself.

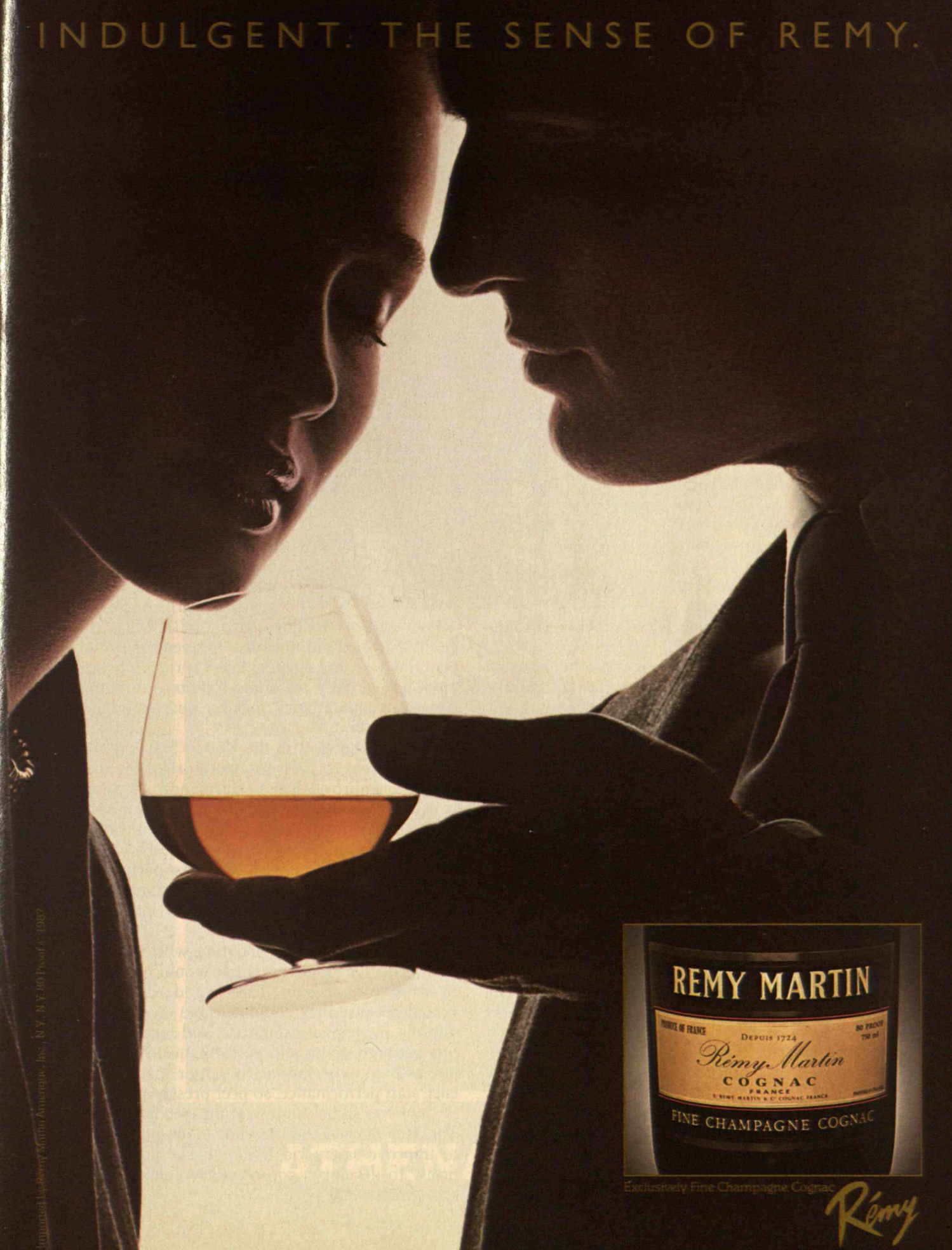
Cooperation Beats Antagonism

The foreign experience nearly eliminates external factors as the major cause of the U.S. nuclear industry's woes. It also suggests internal mechanisms for improvement. A key factor in allowing foreign utilities to boost performance has been industry-wide cooperation. Utilities, suppliers, and regulators all work together on what they view as common problems. Nuclear experts in these countries are baffled by the late start the U.S. utility industry has made in exchanging information, improving equipment, and criticizing itself.

In 1980 U.S. utilities took an important first step by creating the Institute of Nuclear Power Operations (INPO), which works with utilities to improve plant performance and safety and maintains a database on these efforts. This database has already helped the industry reduce radiation exposure among workers as well as cut the amount of radioactive waste from reactors. The Electric Power Research Institute has also long coordinated utility R&D. However, neither organization includes suppliers and regulators as members, so the base of information is limited. Given the deep distrust between utilities and regulators, competition among suppliers, and public concern about potential collusion in the industry, cooperation among all parties will not be easy. Nevertheless, experience suggests that it is crucial.

Closer ties between utilities and suppliers would also help. Managers abroad rely on long-term relationships with suppliers for help in planning major changes in plant design and operation. Because sup-

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port people are often nearby and familiar with a plant, operators can respond quickly to forced outages. The potential benefit is enormous: a 1 percent loss in capacity at a 1,000-megawatt plant costs about $10 million per year in replacement power. Ties with suppliers also allow managers to learn from these firms' experiences at other plants.

Encouraged by public utility commissions, U.S. managers typically solicit competitive bids from many different suppliers to keep operating costs down. This practice undoubtedly achieves short-term savings at the expense of long-term gains.

Our study has convinced us of one other conclusion that is also the most difficult to prove: utilities both here and abroad that show consistently good results operate with a high level of managerial involvement in day-to-day problems. We found that when managers expect top performance from employees and foster an esprit de corps, staff members respond. Others have noticed the same effect. One expert remarked that he could walk into a plant and estimate its performance after five minutes of observation.

Managers can boost their plants' records by maintaining high-quality components, thorough spare-parts inventories, up-to-date instruments for testing and diagnosis, and extensive contacts within the industry. They can also invest in a plant's intellectual resources. U.S. operators must meet certain training levels, but no similar requirements exist for professional staff. Staff members who travel to other utilities are usually top management, not plant operators. Foreign utilities are much more likely to enroll their employees in short, in-house training courses and academic-degree programs, and to exchange employees with other organizations. A similar effort among U.S. utilities is overdue.

Managers would also do well to look to their foreign counterparts for help in solving problems. We sensed little if any interest among U.S. managers in establishing relationships with utilities abroad. Most seemed to feel that the new database created by INPO could provide any information they needed.

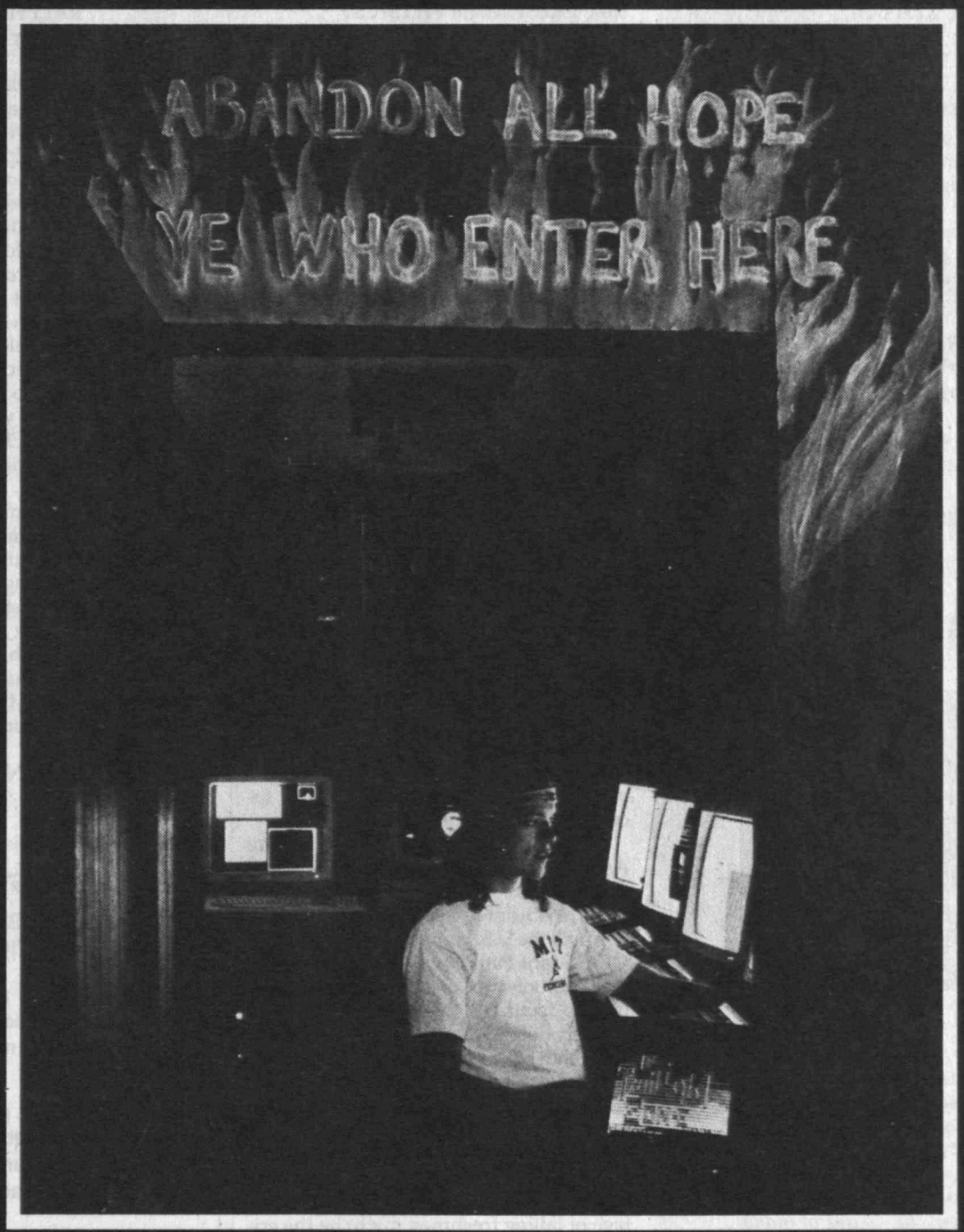
We believe that the U.S. industry should merge INPO's efforts with those of similar databases in other countries. Working contacts between middle-level managers in the United States and abroad would also help. Foreign engineers we spoke with professed an admirable willingness to share information and experience. These experts thought highly of INPO's staff and goals, but they did not have frequent or prolonged contacts with the agency. Since foreign nuclear experts believe they are doing a better job than their American counterparts, they are puzzled by the lack of interaction.

Finally, managers in the United States must take vigorous steps to pressure operators of the weakest plants to improve their performance. Many executives seem unwilling to criticize their colleagues. Very often the attitude is one of sympathy in the face of poor results. This is understandable. However, the entire industry is hostage to its worst performers. As long as some plants fail to meet expectations, people will argue that nuclear power is unreliable and expensive.

The industry is now debating whether to adopt "performance indicators" that would be monitored by utility commissions. These standards are controversial because they could infringe on management options, invite political misuse, and encourage trade-offs between safety and performance. Nevertheless, just as high expectations by senior managers influence staff performance, so peer pressure could prove of immense value in motivating specific companies. The U.S. nuclear industry has taken vigorous steps to improve safety via INPO. It should now move firmly to develop a constructive vehicle for candid self-criticism. ■

MIT

FEBRUARY/MARCH 1989



ATHENA AT HOME

MIT
FEBRUARY/MARCH 1989

WIDNALL, WINGS, & WOMEN 4

PROJECT ATHENA, PART III: ENTER THE STUDENTS 6

ALUMNEWS 11
Cape Cod Water Conference
Presidential Citations
Campaign for the future

UNDER THE DOMES 14
Default of Whom?
Building 20 Coming Down

CLASSES 16
16,000 Miles by Bicycle, Sail, Kayak, and Ski 26

COURSES 36
The "Ultimate Instrument"

OBITUARIES 44

PUZZLE 46

PRESIDENT'S REPORT 49



COVER
The view from the "de-nerdification zone" outside the entrance to an Athena cluster at pika, an independent living group. "Abandon All Hope Ye Who Enter Here," is their tongue-in-cheek motto. But graduate student and former pikan Joseph Harrington, '88, is one of many former and present residents of the house who find it valuable to have a cluster on the premises. The article begins on page MIT 6. (Photo: L. Barry Hetherington)

Controversy over Admissions Policy

CAN "MORE DIVERSE STUDENT BODY" HANDLE MIT FRESHMAN PHYSICS?

As president-elect of the local alumni [and alumnae] club, I attended the May 15 launch in Los Angeles of MIT's *Campaign for the future.* Unlike Theresa Pease, who reported on the event in the August/September *Technology Review* [*page MIT 18*], I was left with less than a warm glow.

The comments of Provost [John M.] Deutch, '61 that the Institute requires "a more diverse entering student population, it requires a broader curriculum" stood in stark contrast to Professor [Robert J.] Birgeneau's private remarks that the Physics Department will most likely be forced to reduce the difficulty of freshman physics so that more freshmen can pass. If they knew, many alumni would be appalled at the results of the fuzzy-brained tinkering with MIT's undergraduate admissions process and curriculum. A great education focused on technology is being diluted by misguided social self-consciousness.

On June 22, the guest speaker for the MIT Alumni Club of Southern California was Thomas Everhart, Caltech's new president. At our request, he spoke about similarities and differences between MIT and Caltech. Dr. Everhart said that Caltech has looked at MIT's decisions to broaden admissions and curriculum and has explicitly decided to remain narrowly focused. [I salute] Caltech.

As I wrote in a letter to the MIT Alumni Association two years ago: How many resources like MIT does the United States have? Without exceptional technology, how will the U.S. compete internationally?

President Paul Gray, '54, has been the architect of the dismantling of MIT's unique focus. At the same time that he publicly decries the poor quality of graduating high school students, he compounds the problem for MIT by weakening freshman admissions and reducing the rigor of undergraduate education.

I would hope that the Physics Department refuses to reduce the difficulty of freshman physics. A significant percentage of failing freshmen might be the crisis that galvanizes the faculty to widespread action.

In the opinion of many alumni, all the rhetoric about a more "well-rounded" freshman and a more balanced education is BS. MIT has been and should remain a bastion of technological excellence. To do less will be an abdication of greatness.

RALPH G. SCHMITT, '66
City of Industry, Calif.

Professors Birgeneau and Deutch respond:
All of us at MIT share some of Ralph Schmitt's concerns. I would, however, like to emphasize that Ralph quoted my "private" remarks out of context. Of course, we have no intention of reducing the difficulty of freshman physics. But some adaptation is required to allow for the more varied backgrounds our freshman instructors encounter in the current student body. Further, we hope to make the basic physics curriculum more relevant to modern science and current technical issues. This is an evolutionary process that will occur over the next several years.

ROBERT J. BIRGENEAU
Head, Department of Physics

I regret that Mr. Schmitt missed the central thrust of my comments at the Los Angeles Campaign Kickoff. My point is that MIT's science and engineering students must attain an understanding of how society can successfully adapt the benefits of new technology. This is not fuzzy, nor is it rhetoric. It is a sharp appreciation of what is required by MIT science and engineering students for leadership in the future.

JOHN M. DEUTCH, '61
Provost

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GERALD L. WILSON, '61

Designing a Better Engineer

All is not well in American engineering. There are plenty of indications that engineers' traditional mode of operating is no longer good enough:

- U.S. industries are losing out to overseas competitors who design, build, and market new products faster—quality products that better meet the needs of consumers.
- We build nuclear power plants, neglecting to make adequate plans for processing the spent fuel and without making the effort to understand why the public fears nuclear energy.
- We build chemical plants, ignorant of the effects of the downstream effluents on the water supply and on wildlife, and ignorant of the interrelationship between the plants and the local infrastructure.
- Waste disposal has us all but stymied. We don't know what to do with the trash we produce at home, on the farm, in the factory. Garbage barges cannot find a place to unload; syringes and blood bags wash up on our beaches; poisoned dolphins beach themselves to die.
- For 30 years, we've been adding to the amount of CO_2 in our atmosphere by continuing to burn fossil fuels. This hot summer, we finally started reading serious articles in the popular press about the greenhouse effect.
- We fight about building a secondary sewage treatment facility in Boston Harbor, when in fact every time it rains, water overflows the city's antiquated sewer/storm-drain system and bypasses even the two *primary* treatment plants.

These issues are not going to go away. I think that the only solution, if there is one, lies with our educational system. We must have a better-informed citizenry, with a clearer understanding of technology. And we must teach engineers how to lead that education process. The teaching of engineering must be revitalized, building on all the many things we are doing right, but changing the emphasis.

An understanding of more than one engineering specialty and other undergraduate experiences that prepare students to work in interdisciplinary teams; more design work; and broad exposure to the economic, political, and social issues involved in large engineering projects—these are some of the elements of a refocused engineering education.

GERALD WILSON is the Dean of Engineering. This column is based on the Robert Bruce Wallace Lecture for 1988, which Dean Wilson delivered in October.

Many faculty fear that we are going to sacrifice depth for shallowness.

(One of the reasons that it is so important to offer more effective design in our curriculum is that we have a crop of students with different experiences than many of our alumnnae/i. Years ago the students who came here had built things: They built and operated ham radios, they ripped apart cars, and they made go-carts of gasoline lawn mowers. This is not as true of the students we have now, so we have to give them the opportunity to conceive something and see it run.)

The reformulated priorities for the School of Engineering came together clearly in a preliminary "mission statement" that was developed in 1988. The statement was the work of members of Engineering Council (the heads of engineering departments as well as the directors of laboratories and research centers), meeting with nine other faculty members—randomly chosen—for a retreat on Cape Cod. They assigned first priority to addressing the relationship of engineers to society much more carefully than we have in the past, and second, they decided that MIT has to educate engineers to deal with ambiguity and complexity.

The leaders in this effort to change engineering education have to be the faculty. But the engineering faculty may not yet be convinced that this new direction is appropriate for MIT. For one thing, engineers hate ambiguity. They hate dealing with decisions that can't be answered in relatively precise terms. But more and more, they face projects involving substantial social impact and a roomful of people who must agree on the technology, in situations where there are potentially many workable solutions but no "right" answers.

Many of our faculty are already involved in outside activities that engage them in the large issues. They teach in the technology policy area. They serve on national boards that set science and technology policy. They testify before Congressional committees. They are expert witnesses at public hearings. The problem is, their students do not see them do these things, by and large. Their students still see them in the laboratory or the classroom, pursuing a narrowly defined area of technology. That has to change.

Then there are the faculty who *are* narrowly focused technologists, and who think that work in the policy field is "soft," inappropriate for MIT. These skeptics think that social issues are what you worry about when you get old, when you have lost your technological edge (in other words, when you get to be a dean). These are the people we must win over. They are afraid that we are going to sacrifice depth for shallowness, that our program will be not so much enriched as watered down.

It is not so surprising that many of the faculty think this way: they were brought here and have been rewarded for many years for being narrowly focused and for being world leaders within narrow specialities. We are talking about a massive change in attitude, and that could take 15 to 20 years.

I still believe, strongly, that our students must go into some field in depth—to ensure that they know *how* to do it and to develop their confidence that they *can* do it. What I am advocating is that we stop calling that kind of knowledge "enough." It is not enough.

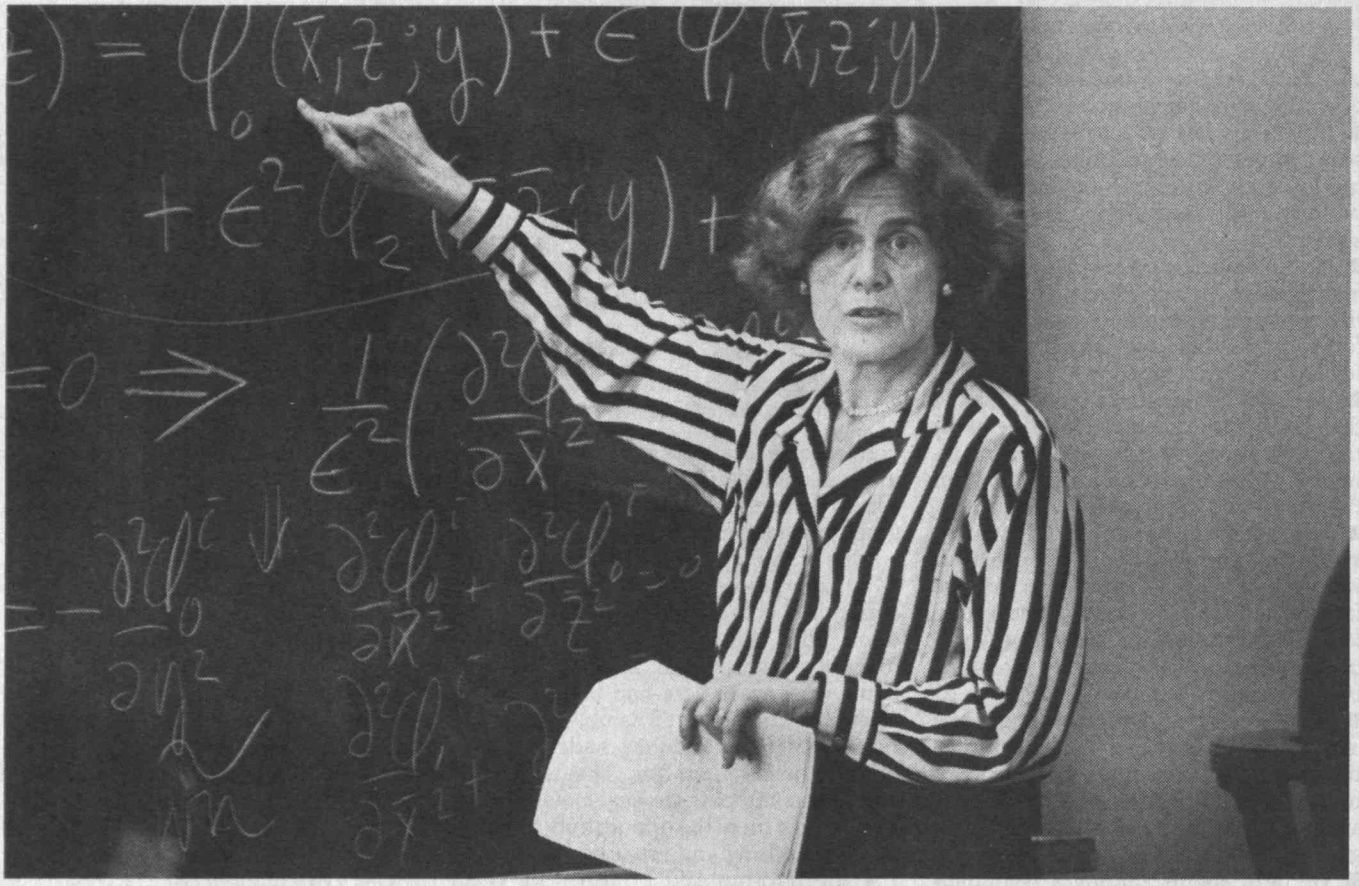
This is a capable faculty, and they are fairly knowledgeable about what's going on in the world. If we can agree that it's time for us to address these issues, we've got all the talent here to put together a response that could be important for the country. What we are trying to do now is make a lot of people think about these issues.

An example of what I want to change is the situation where MIT graduates are told that their solution to a problem has to fit in the following box because the lawyers have to make the box easy for the engineers to understand. I want to turn out engineers who are prepared to look at the legal complexities, who are involved in understanding and

Continued on page MIT 13

SHEILA WIDNALL, '60

Minimizing the Drag on Wings—and Women



Although women often enter graduate school with a higher grade-point average than men, their self-esteem is consistently lower, according to graduate student surveys cited by MIT Professor Sheila Widnall, '60. Women at MIT and Stanford expressed serious doubts about their abilities—abilities equal to or exceeding those in which men expressed self-confidence. And while male students' self-esteem rises during their undergraduate years, that of females declines.

Such self doubts seem not to have burdened Widnall herself, the Abby Rockefeller Mauze Professor of Aeronautics and Astronautics, the first woman faculty member in her department, and the first woman to chair the MIT faculty. She was the fifth woman to be president of the American Association for the Advancement of Science—and only the fourth engineer. At the AAAS, she has noted, engineers may be more of an exception than women.

Despite her own clarity of purpose, Widnall understands the struggles of women who would be engineers. She is heartened that this year's MIT freshman class is close to 40 percent female, up from 2 percent in her freshman year. But she has not observed a proportionate cultural change in the male-influenced institution, and that is a problem for the growing numbers of women students.

Widnall sees increased participation by women as critical to keeping science and technology strong. Without them, those fields are predicted to shrink dramatically in the coming decades. Given the diminishing quality of science and math education at the elementary and secondary levels in the United States, it is no insignificant matter to attempt to plug leaks in the pipeline where students who have shown aptitude and interest in a scientific career are trickling away.

Growing up in Tacoma, Wash., Widnall gained confidence in herself at an age before girls often become inoculated with the notion that science and math are beyond their abilities. She learned from her father, a machinist, how to take things apart and put them back together. Her mother, a juvenile probation officer, provided her with a model of a working woman. And both parents trusted her to chart her own course.

She attended a Catholic girls' high school where everyone took science courses and there could be no polarization by gender. To learn physics she had to venture abroad to a public school, but she found that she was more motivated than most of the boys. First prize in the local science fair provided encouragement and brought her to the attention of Arthur Anderson, '35, a member of the MIT Educational Council. He urged her to attend the Institute.

Accepted as one of a handful of women in the 1956 freshman class, Widnall graduated in aeronautics, received the Sc.D. in 1964, joined the faculty after a postdoctoral fellowship, and was named full professor 10 years later.

Widnall's research area is fluid mechanics and aerodynamics, with a specialty in vortex structure and behavior. One of the requirements for maintaining vortex motion is a continuous supply of energy to

PHOTO: L. BARRY HETHERINGTON

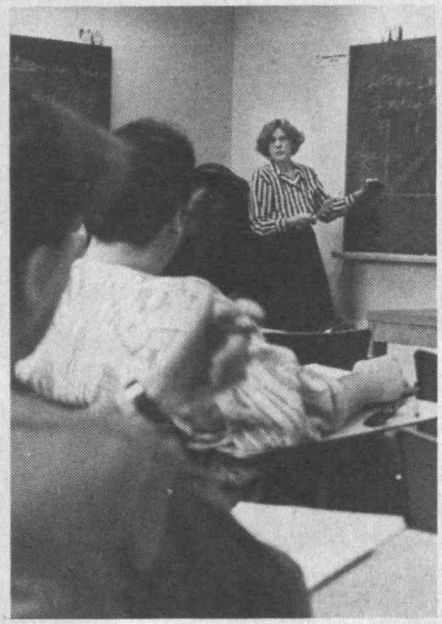
overcome friction. She has served as a similar source of sustained energy in her efforts to help other women navigate the career path that she herself followed—or at least something close to it. Though trailblazers are by definition atypical, Widnall understands well enough many of the problems engineers and women face in school.

The graduate research environment has inherent stresses in the competition for funding and the pressure to achieve results. Women carry an extra burden in trying to determine how to combine family and career responsibilities. Research ground is lost—often irretrievably—if a woman takes time out to have a baby. Widnall was fortunate to have live-in help with her own two children and took virtually no time off, but she recognizes that such options are not available to all. A graduate student who is struggling to balance her dual goals may lower her career ambitions, become "unsure of her potential," and end up dropping out of school.

Widnall suggests that one of the most effective antidotes for such uncertainties is the opportunity for successful experience in research, employment, and interaction with other students. The support and encouragement of a faculty mentor is also needed. Female students report that many of these opportunities do not arise, sometimes because of overt discrimination, sometimes owing more to a lack of awareness on the part of faculty, male students, and even the women themselves. If women know that they might have a tendency to internalize criticism or accept frustrating circumstances that could be changed, they have a much better chance of adjusting their responses to stress or speaking up for themselves before the situation drags them down.

Since the composition of the MIT student body is constantly changing, it would seem unlikely that male students would be responsible for perpetuating an unwelcome environment. However, they are very competitive, says Widnall: "When you come to MIT you're put under tremendous stress. If there is any way you can rationalize your position in the hierarchy by putting another group at some disadvantage, there's a kind of personal payoff for doing that."

Another source of friction arises from the "combative style of communication within [some] research groups," observes Widnall. "Men often feel perfectly comfortable with a communication style that seeks to reduce one of the protagonists to rubble in the course of a scientific discussion. After the storm is over, they quickly forget about the incident." Women students often feel that winning points only at the expense of putting someone else down is an unacceptable mode of scientific debate. Widnall suggests that the graduate experience would be enhanced for all if students work to make the research group interaction a positive-sum game, while being no less insightful and scientifically critical. She believes that when the academic environment is improved for women, it is improved for men as well.



Professor Sheila Widnall teaching a graduate class in fluid mechanics.

Faculty, too, Widnall believes, can make life rough on female students, both inadvertently and purposely. Some professors have difficulty taking women students seriously—a perception exacerbated when women are juggling career and family ambitions. Studies conducted by the Project on the Status and Education of Women for the Association of American Colleges show that when male and female names are switched on papers and resumes, the potential and accomplishments of women are consistently undervalued—not only by male evaluators, but by females as well. In response to continuing reports from women students of inappropriate treatment and prejudicial remarks from some faculty, Widnall calls for "a willingness on the part of faculty to publicly challenge professional colleagues" who behave in such a manner. Attitudes *have* been steadily, if slowly, improving, and Widnall is encouraged by the changes she sees.

A firm believer in careful studies of problems, Widnall is a veteran of countless committees covering a spectrum of issues, including many of the concerns of women. She quickly dispels the notion that a committee is merely an excuse to *appear* to be addressing a problem. "Not *my* committees!" she laughs. She describes herself as a tactical fighter who enjoys "grabbing hold of an issue, working on it intensively, and then feeding it into a larger structure." It is the same way she approaches her research in fluid dynamics.

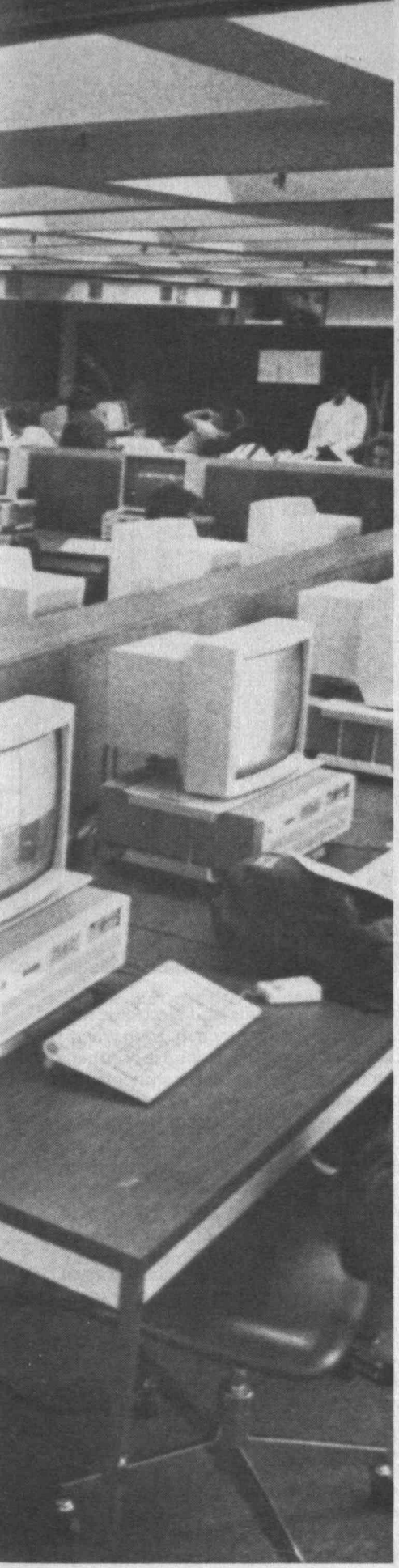
The Women's Faculty Group, which Widnall co-founded in the early 1970s with Institute Professor Mildred Dresselhaus, has tackled many "environmental" issues for women, ranging from MIT's athletic structure to career development for women faculty. The women's athletic program underwent a substantial overhaul as a result of the group's study, which illuminated the lack of parity between the availability of equipment, coaching, and facilities for men and for women. And the group initiated workshops to increase the number of women faculty at MIT by ensuring the best possible development for the careers of those who are here.

Widnall has long understood that success breeds success—a pivotal example occurred in her own research in the early 1970s when the right project and people combined to produce work on the motion and stability of vortex rings that received national attention. The accompanying boost in her self-confidence allowed her to do even better work. Many of her efforts on behalf of women have been to create an environment and an attitude at MIT where such "happy accidents" are not so accidental.—*Faith Hruby* □

Note: Some of the background information for this article was found in the "Women in Science and Engineering Oral History Collection" in the Institute Archives & Special Collections of the MIT Libraries.



The Athena cluster in the Student Center.



Students Log On to ATHENA:

Test Subjects, Technicians, and Critics

BY SIMSON L. GARFINKEL, '87

In the basement of a house in Cambridgeport, there is a tiny room with black walls, a black light, two mattresses on the floor and a pack of wintergreen Life Savers taped to the wall (they spark in the dark if you crush them). The room's entrance is set off from the rest of the basement by a black curtain. On the back wall is a door leading deeper still, with the words "Abandon All Hope Ye Who Enter Here" painted in fluorescent green letters.

Behind the door is a larger room housing seven Project Athena workstations, two file servers, a laser printer, a gateway that connects the cluster by telephone lines to the MIT Campus Network, and a futon. This is a Project Athena "living group cluster" at an independent living group known as pika. The black room is called the "de-nerdification zone."

Pikans have achieved something that may prove significant: they have personalized the anonymous Athena computer room, making it conform to the house style.

One element of the Athena experiment was to see how students react to living with the machines. In spring 1986, Athena solicited proposals from interested living groups: five of the 19 submissions were awarded grants of equipment and a network connection.

"It was a question of costs," explains Steven R. Lerman, '72, who was Athena's director at the time. The living group program was a pilot project paid for by a special grant from the Provost's Office, Lerman says. "Five groups were all we could manage, handle, and afford." Today, in addition to pika, there are clusters in three fraternities—Zeta Beta Tau, Delta Upsilon, and Theta Delta Chi—and one dormitory, 500 Memorial Drive.

Heidi Burgiel, '90, who lives at pika, is glad that the computers are not in students' rooms. "That way, we would be living with the computers instead of visiting them."

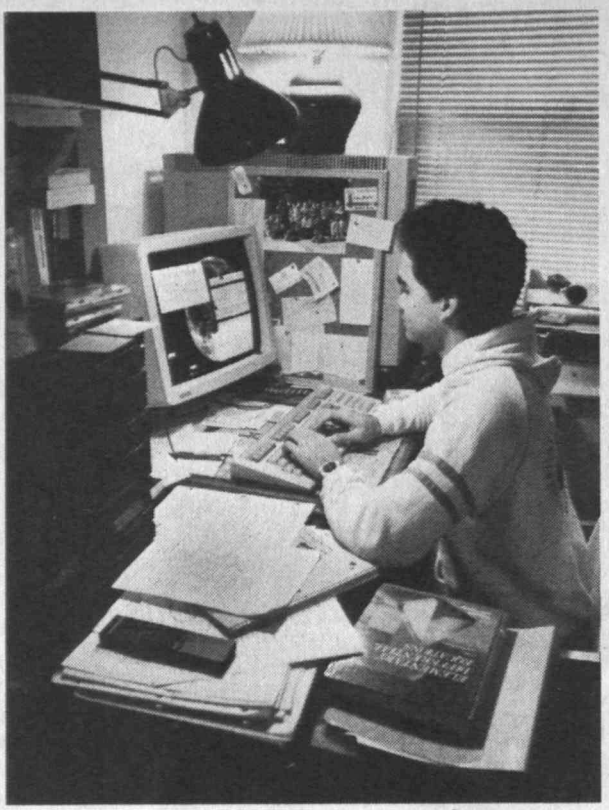
But Burgiel wouldn't want to be without the workstations: "It's awfully nice to have them there," she says. "You don't have [a 20-minute] walk to the Institute to do your homework. You can eat next to [the computers] and nobody complains."

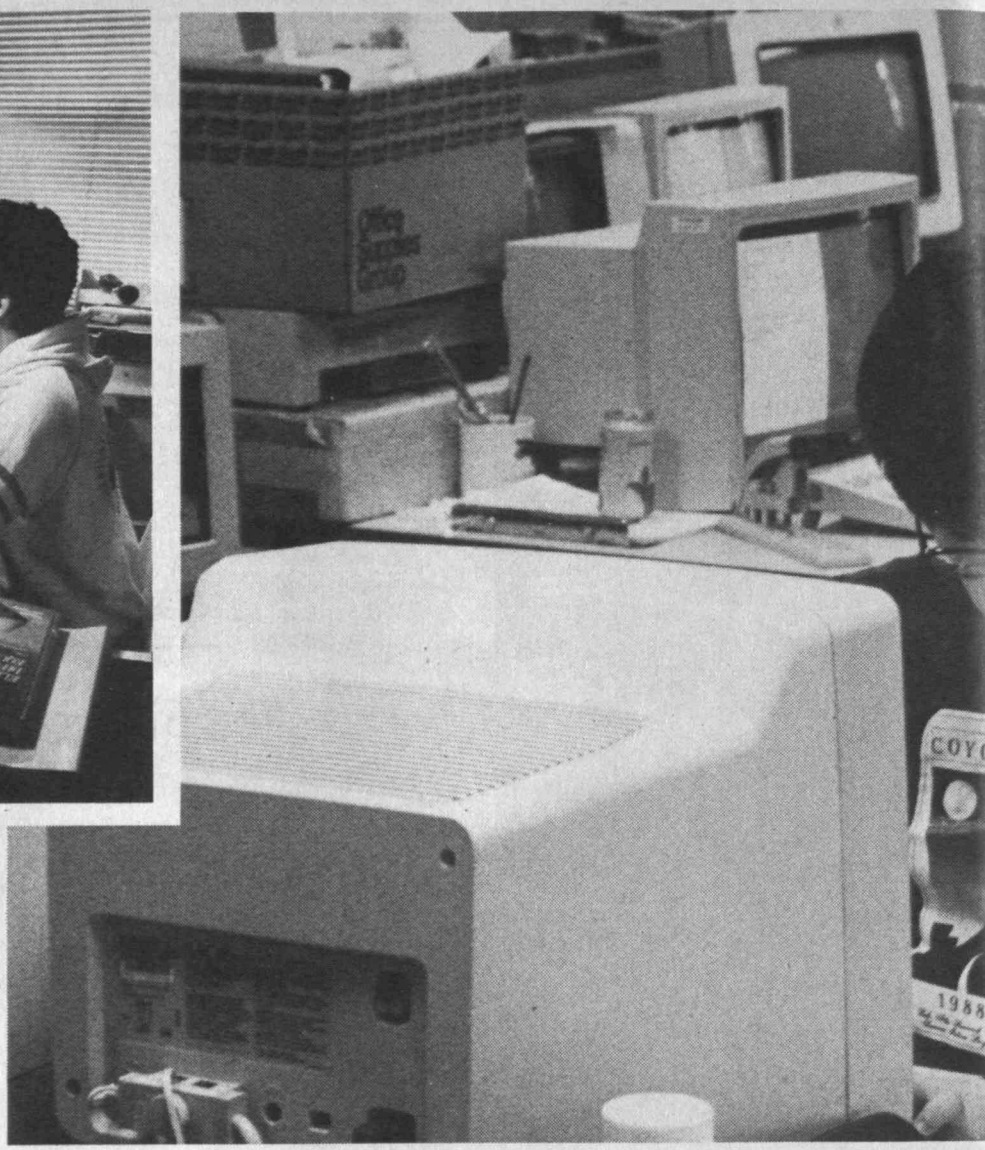
Students in the other living groups that have the machines agree, but when they try to attract new freshmen during the first week of school, they don't heavily advertise their Athena connection.

Pikans opted for the basement cluster in part because they were concerned that a machine in every room would increase the likelihood that freshmen would choose the living group for its computers instead of for its people and lifestyle. TDC, the

SIMSON GARFINKEL is a freelance writer based in Somerville, Mass. He joined the SIPB in 1984 and remained an active member until May 1987.

PHOTOS: L. BARRY HETHERINGTON





Above: Zain Saider, '92, lives at Theta Delta Chi, one of the few living groups participating in experimental placement of Athena workstations in individual student rooms. Right: Aaron Goodisman, '90, is working in the equipment-jammed offices of the Student Information Processing Board.

fraternity that has an Athena workstation in every student's room, uses the machines as a filter during rush: any freshman who seems too interested in the computers is politely asked to look at another living group. "We were worried about a hacker subculture," says Zain Saider, '92, TDC's Athena liaison.

Problems in the Hinterlands

Saving that 20-minute walk to campus has had its price. Since September 1987, there have been major improvements to the Athena operating system that made the machines at pika and DU—still running the old software—largely incompatible with the workstations on campus. Workstations in those living groups cannot use much of the course-specific software that Athena has struggled to develop, nor can they automatically access files stored on campus.

It's an authentication problem, explains Jeffrey I. Schiller, '79, Athena's manager of operations. If the updated operating system were installed on the remote machines (those too far away to be hard-wired into the network), each time the special phone lines were down—which can happen for days at a time—Athena would be unable to authenticate student passwords. In that case, students would not only be barred from the network, they would be unable to log on to the machines in their own living group. Until the technical problems can be solved, the remote living groups are sticking with an obsolete version of the operating system, but one not entirely at the mercy of the phone links.

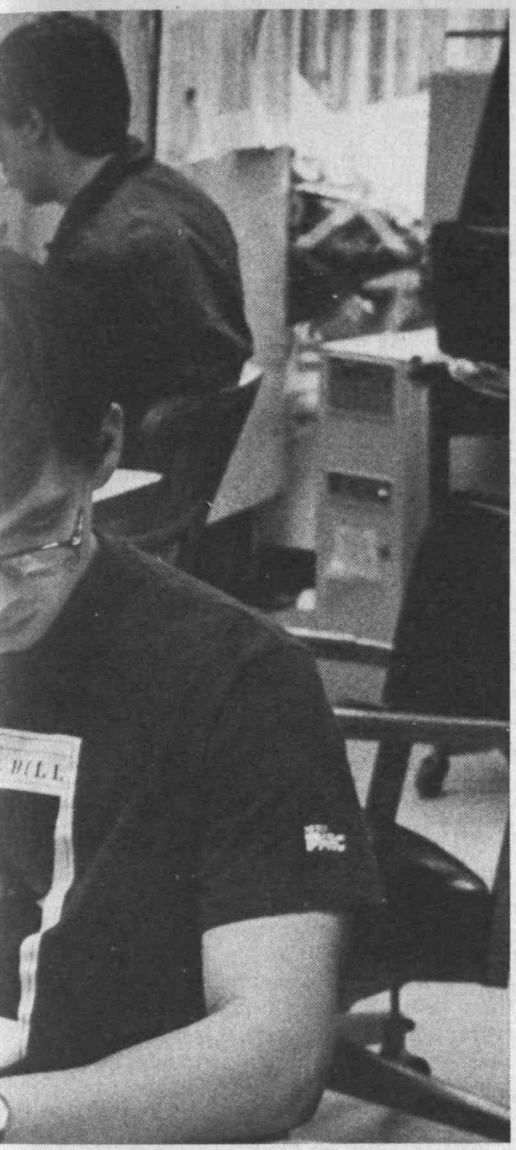
To date, however, the inability to run course-specific software hasn't been a big issue for the living groups. For most students who have used Athena in the past five years, "courseware," as the software is called, has not been a central feature of the Project. According to Athena's 1988 student survey, 65 percent of the students used Athena for personal purposes, compared with 49 percent who used it for courses.

In general, more students used Athena for word processing and electronic mail then for any other function. Even when a class assignment called for use of Athena machines, 47 percent of the students simply used standard application programs, such as word processors and spreadsheets that were not written for the Project. Another 22 percent wrote their own programs. Only 37 percent of the students using Athena for a subject ran course-specific programs.

Student Information Processing Board: A Distinctly MIT Organization

Before Project Athena, MIT students who wanted to learn about computers but didn't have access to the machines in a subject or a laboratory could apply for a grant from the Student Information Processing Board (SIPB). No cash changed hands, but students were given dollar-value accounts on MIT's mainframes, most often a machine called *Multics*.

SIPB's resources came from MIT's Information Processing Services (IPS), says



Weston Burner, a past director of the service. SIPB's assignment was to screen students who wanted to use the computers for independent projects from those who needed machines for course work.

IPS didn't want to fund student work that was within a class assignment, Burner says. If a professor at MIT wants the students to use the computer for a class, the students should be allocated computer time through the instructional budget. IPS saw students as being better able to determine how computer time would be used than administrators—a distinctively MIT mode of operating.

SIPB's sponsorship of *Multics* accounts was originally limited to students who wanted to learn how to program. Then in the early 1980s, that restriction was lifted and SIPB began funding word processing. By 1984, says Jon A. Rochlis, '85, a former chairman of the organization, SIPB was sponsoring accounts for nearly 2,000 students—almost half the undergraduate population.

In the fall of 1984, one of Athena's VAX-750 machines, known as *Charon*, was designated for SIPB's exclusive use.

"The idea was to give students a place for experimenting with the lowest levels of the Unix operating system," Rochlis says. For example, SIPB made *Charon* the only Athena machine able to communicate with MIT's home-built network called CHAOSNET, thus able to talk to the Artificial Intelligence Laboratory and the Laboratory for Computer Science. But SIPB's main use of the machine was as a test-bed for developing software that could be used by the entire Athena community.

Among the SIPB products was a program that enabled students anywhere on the Athena system to typeset papers using IPS's high-speed Xerox laser printers, at a time when no such service was provided by Athena. SIPB members also designed a computer bulletin board for the workstations called "Discuss," which allowed students on different workstations to participate in electronic discussions on a variety of topics. When computer games began to absorb too much time on *Charon*, one SIPB member wrote a program that automatically terminates any games that are underway when the system is running too slowly. This program was adopted by the rest of the Project before the move to workstations.

SIPB was filling in the cracks, Rochlis says, between what students needed and what Athena was providing. When it felt that Athena's instruction manuals were inadequate, SIPB wrote its own and made it available to students. When students demanded the ability to call Athena from their living groups, but Athena had only budgeted modems for faculty and staff, SIPB used its own capital budget to purchase modems for Athena computers.

SIPB also offers consulting services to students with problems or questions, which generated some friction. "The Athena consulting staff . . . didn't want a volunteer organization like SIPB to come in and consult," Rochlis says. "[Athena] had to control the quality of answers. . . . [By discouraging the volunteer efforts of SIPB] I think Athena missed a big opportunity."

MIT students can be harsh critics of activities, particularly technical activities, in their surround, and SIPB members were not the only MIT students who had strong opinions about how Athena should be implemented. In the early years of the program, Athena staff functioned in an environment of frequent complaints from students.

Case in point is the experience of Experimental Study Group, a self-paced, tutorial-based alternative academic program for freshmen and some sophomores. In 1985, ESG applied for a small Athena cluster, says Joseph Harrington, '88, (the fourth generation of that name to graduate from MIT) who was a freshman in the program at the time. "There weren't any workstations, so they gave us IBM PC/ATs to hold us over," says Harrington.

Having the machines installed was another matter. For starters, ESG students wanted to lay their own wiring. "We wanted to get things moving as quickly as possible, and installing pieces of coax cable is a relatively simple thing to do," Harrington says. But Athena had forbidden them to do so.

Finally one day the network installer showed up. "He looked at his crimping tool, looked at the wiring kit, looked at us, and said, and I quote, 'Do you know how to use this?' " Harrington recalls angrily. The students showed the installer how to use the tool, and he proceeded to wire their cluster.

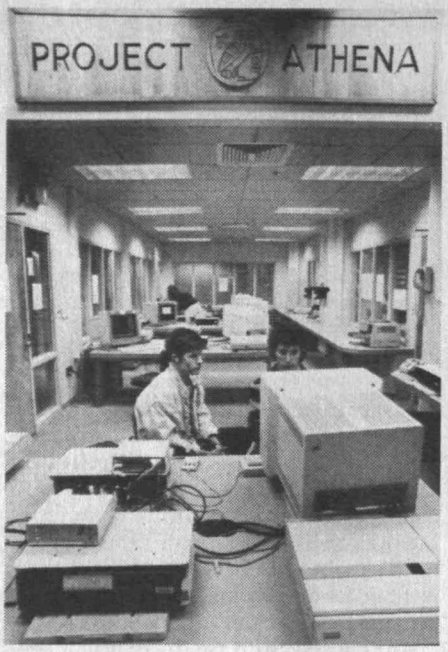
"We waited a long time for him to come, and it turned out we could have done the job ourselves," says Harrington.

The problem, Steven Lerman explains, is that "it is easy to screw up a cabling installation, and it's very hard to support an installation that you didn't install." In any event, many students and faculty believe that the new Campus Network is the property of Project Athena, but it is actually owned and operated by the MIT Telecommunications Systems. Athena is just one of the network's customers.

"If any one player screws up [the network]," Lerman says, "everybody loses service." For that reason, Telecommunications Systems had a firm policy to support only networks that it installed.

After the machines were installed later that summer, ESG and Athena struggled over how they would be used. Project Athena had supplied the IBM PC/ATs with a standard software package and a program called "SAFE," which automatically deleted any non-Athena program from the computer. "The first thing we did was delete that program," Harrington says.

ESG students wanted to run off-the-shelf software, Harrington says, like "Wordstar"—programs that Athena specifically told them to avoid. He says the Athe-



The "Fishbowl" cluster in Building 11 is equipped with state-of-the-art video workstations assembled from IBM, DEC, and Paralax components.

na staff feared students might become dependent on MS-DOS programs, making the transition from MS-DOS to the Unix operating system that much more difficult.

That wasn't all. Students wanted to keep their files on the PC/ATs' hard disks, but Athena demanded that they use floppy disks. Floppies were slower and not large enough to store the computer pictures with which the students were working.

Harrington saw a tug of war between Athena, which wanted all of its PC/ATs on campus to be standard, and the students in ESG, who wanted to use the machines in their classrooms as they saw fit. The difference of opinion was no small matter.

The ESG students started ignoring Athena's proclamations. "We knew what we wanted to do," Harrington says. When Athena staff came through, the students loaded their data from the hard disks onto floppies and deleted the changes from the PC/ATs. Tensions finally eased in March 1988, when the PC/ATs were replaced with two Digital and three IBM workstations. Finally Athena had achieved its goal of installing standard Athena workstations in ESG, and this time they were workstations that the students could use without modification.

Lerman denies that Project Athena ever had a policy forbidding the use of outside software on the ESG computers. He points to the School of Architecture and Planning's successes in using commercially available programs as proof that no such policy existed.

But Lerman isn't surprised that Harrington and others inside ESG had such misperceptions. "That's very common at the Institute," he says, dubbing it "policy by myth-vention."

"Myth-vention," says Lerman, is when "a myth becomes established and people view it as a stated policy. It reflects the difficulty of communicating with large groups of people about rapidly changing things." Myth-vention was rampant at Athena.

"I always had problems communicating the current policy. . . . So many downstream problems were created by bad communication—people believing things to be true that weren't, or not knowing things that were [true]." There are now Athena officers with specific responsibilities for sharing information with faculty and students, but if he had to do it over again, Lerman would have hired someone to handle communication at the very beginning of the experiment.

Some students have found themselves in the enviable position of being paid to use Project Athena. These were the students who wrote programs and who were the Project's paid consultants, developers, and operations staff.

The computer code for nearly every Athena faculty project was written by students. The Department of Aeronautics and Astronautics' fluid dynamics system was written in part by 38 undergraduates. "Some [students on that team] worked out extraordinarily well, some were extraordinarily unsuccessful, and most made some contribution," says Professor Earll M. Murman, who supervised the project. "All learned something about fluid mechanics and something about Unix. They all ended up ahead."

At the same time, Athena itself was developing a small band of top-flight computer hackers to do system development and fix bugs in critical pieces of software. David G. Grubbs, the Athena systems programmer who hired them, called them "watchmakers"—a catchy name he borrowed from a science fiction novel, *The Mote in God's Eye*, by Larry Niven and Jerry Pournelle.

"I remembered [watchmakers as] this group of little creatures who sort of dived into anything and optimized it," says Grubbs, who today works for Digital's Ultrix Group.

Athena's watchmakers performed much the same function. Grubbs would give them a list of things that needed to be done and set them loose. "If you want to do any of these," he would say, "go to it. If you don't, tell me why." It was a pretty free environment, Grubbs believes, but very demanding. "The students may have thought that I was pushing them at times—which I did when I needed help. They were my only resource."

Responsible for Athena's software releases, Grubbs often found himself working 80 to 140 hours per week and sleeping in his office 10 to 15 nights per month. Every once in a while, he would say to his student staff, "Look, I need help. I don't care how you get the time, but come help me." The students would pull through, even if it meant staying all night to get a piece of software or one of Athena's time-sharing machines working again.

The watchmakers lived on after Grubbs left, but they gradually assumed a less important role.

"I use them in all phases of what I do here," says Daniel E. Geer, Jr., '72, who has managed system development for the last three years. "Athena would not get by without them, frankly. That is not to say that they are the only show in town, as I think they were when David Grubbs was around."

Geer says that he has restructured the system development group, which has grown from 20 to 30 people since his arrival, so that projects are now developed by small teams. Students are on the teams and are occasionally team leaders. "The point here, however, is that the students can't be expected to take long-term, full-time responsibility for things. It doesn't fit in with being a student," Geer believes.

A third group of students, the gremlins, were hired to patrol the clusters, inspect the equipment, and perform periodic backups. Like the other students on Athena's payroll, their principal motivation wasn't the pay, but the fringe benefits: virtually unlimited access to Athena's resources at a time when other students were barred from the system or limited to using the crowded machines at the Student Center.

For the student staff and SIPB members, Athena was an adventure—for some the pivotal experience of their undergraduate education. But for the majority of students, the first four years of Athena were at best unnoticed, at worst a major frustration. □



ALUM· NEWS

Cape Cod Club Gets Down to Basics: Water

Cape Cod depends on ground water; it's classified as a "single source aquifer." And like the land and the infrastructure, the capacity of the water resource is being stretched to the limit by unbridled growth. (The population of Barnstable County, for example, grew by 53 percent between 1970 and 1980.)

So the MIT Club of Cape Cod's October conference on water resources management for Boston and the Cape hit a topic high on the local agenda. But the conference message—that both political commitment and technical understanding are essential in dealing with environmental problems—wouldn't be wasted anywhere.

The conference was organized by Regional Director Janet Serman of the Association of MIT Alumni and Alumnae. It brought together scientists, entrepreneurs, and leaders of government and private agencies to address from every possible angle the problems of treating wastewater and protecting drinking-water supplies.

Many of the conference participants seemed intent on gathering ideas to take back to their own communities, and ideas were in rich supply. In fact, the only flaw in the whole program was the small attendance, which is generating discussion in the Association about how alumni/ae groups can attract appropriate audiences to the kind of thoughtful program they are prepared to put on.

The potential power of the committed individual was well documented by keynote speakers Judge Paul G. Garrity, a pivotal figure in launching the cleanup of Boston Harbor, and Paul Tsongas, *the* pivotal figure in efforts to impose a moratorium on Cape Cod development until the consequences of further development can be understood and prepared for.

Tsongas' arrival at the conference was delayed, so Garrity led off, assuring participants that "like Fidel Castro, I can talk all day." Garrity's theme was that it is the failure of political will, more than anything else, that threatens water and other critical resources. He used Boston Harbor as an example of the way the executive branch of government can ignore and evade federal and state laws.

It took action by Garrity, as state Superior Court judge, to even determine how polluted the harbor actually was. (It turned out to be the worst in the nation.) And by imposing a freeze on development in the Boston area, Garrity pressured the Legislature into establishing a new agency to clean up the harbor.

The lesson to be learned from all this, Garrity emphasized, is not that people should look to the courts to resolve a political stalemate. He noted that judges are relatively inaccessible, appointed for life and accountable only to appellate courts, and must focus solely on compliance with the law. Better that critical and thorny problems should be addressed by officials accountable to their constituents, Garrity argued, officials who can consider not only the law, but all of the community's economic, environmental, and political priorities as well.

Since Garrity left the bench to return to private law practice, he has done more than just talk about political responsibility. He devotes a lot of his energy to "Save the Harbor, Save the Bay," a citizens' group working to keep the government moving ahead on the cleanup—in Garrity's words, "holding the politicians' feet to the fire."

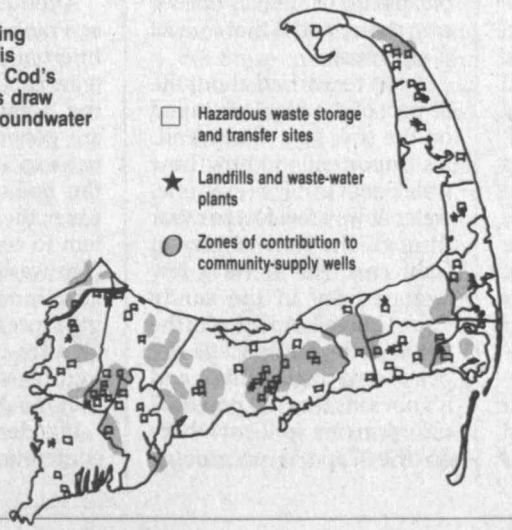
Skeletons in the Closet

Tsongas is a respected if sometimes controversial public figure and formerly a Democratic (what else?) senator from Massachusetts. He opened his remarks by admitting that the "skeletons in the closet" of his family are "two wayward uncles who went to MIT and subsequently became Republicans." The wry humor that peppered his talk, however, could not hide the passion behind his fight to save the environment of Cape Cod, his family's adopted home.

Tsongas was reluctantly enlisted as the chairman of the Massachusetts Special Commission on Environmental Operations. He needed a concrete issue to galvanize public opinion and compel people to focus on the political issues inherent in preserving the Cape environment. Tsongas was publicly berated by just about everyone after he persuaded the commission to call for a moratorium on development on the Cape. Then the *Boston Globe* did a survey that showed that 67 percent of Cape residents supported the moratorium.

"From being the head of rag-tag army, I was now at the head of a juggernaut," quipped Tsongas. (When the non-binding referendum came to a vote in November, the moratorium was approved by 69% of the voters.)

But a moratorium would be a heavy-handed way of protecting the Cape aquifer,



Crises in the making are revealed by this map of how Cape Cod's water-supply wells draw on endangered groundwater resources.

MAP: MICHAEL H. FRIMTER, U.S. GEOLOGICAL SURVEY

Tsongas said. A moratorium makes no distinction between development that is valuable for a community and development that threatens the lifestyle of residents and the aquifer on which they depend. It was Tsongas' hope that faced with the prospect of a complete halt to development, Cape communitity leaders would face up to the imperative for collective long-range planning as opposed to fragmented and unchecked growth. That seems to be happening.

Having initiated the vote on the moratorium, Tsongas then went on to suggest a better strategy to protect the fragile Cape environment: the "Model Town" program. The program evolved into a scheme that saves all the towns from having to simultaneously solve their problems with water supply, zoning, waste disposal, and the like. Instead, towns have been selected to work on specific issues in collaboration with the MIT Department of Urban Studies and Planning or another of the universities that have joined the effort, in hopes of developing management strategies that can later be adopted by the other communities.

Water management schemes for the Cape will be based on the information assembled by Michael H. Frimpter, head of the Massachusetts unit of the Water Resources Division, U.S. Geological Survey, and his colleagues.

Frimpter explained that the legal restrictions around the placement of a well are not realistic safeguards of water quality. To protect a water supply, we must actually protect the "zone of contribution," the watershed area within which underground water—and any pollutants that seep into the underground water—flow towards a particular well. The zone of contribution is not a fixed distance around the well, Frimpter said ; it is rather a function of the geology of the area and the rate at which water is being pumped out.

Frimpter's map of the zones of contribution of community wells on the Cape, overlaid with maps showing the sites of landfills, road-salt storage sites, sewage plants, and other major sources of contaminants, was an alarming scene that could probably be repeated for many areas in the United States. The maps were more effective than words in alerting Cape residents to the threats to their water supply.

Even for planners who are mindful of the watershed they must protect, it's not always obvious how to do it, as Phiilip Gschwend, an environmental chemist at MIT, made clear. Not every chemical that humans produce is cause for alarm, he said, and it takes a lot of work to identify the problems. The relevant questions for him are: What chemicals are being introduced into the environment from what sources; how do they travel and come in contact with people, plants, or animals that we care about; and is that contact dangerous?

If you're worried about the impact of chemicals dumped on the soil, says Gschwend, it's important to know how water moves. For example, water flows a few feet per year through the packed clay of California, but flows a few feet per day in the sandy Cape Cod soil. Add that to the fact that the entire Cape depends on a single aquifer, and it's obvious that the potential risk from one spill anywhere on the Cape is enormous. What is equally worrisome, Gschwend said, is the fact that chemists are able to monitor only a few hundred of the tens of thousands of chemicals in household and industrial use.

Enough is known about the hazards posed by sewage, however, to keep environmental entrepreneur John Todd in business. Todd is alarmed at the way we are treating or removing compounds found in sewage by introducing other chemicals that may be just as dangerous.

As an alternative to traditional chemical-based wastewater treatment, Todd's organization, Four Elements Corporation, is introducing solar aquatic treatment systems to Cape communities. They route raw sewage through beds of aquatic plants and organisms (bacteria and snails, for example) that metabolize the offensive products. In an experimental septage system built for the town of Harwich, the final product is cleaner than the standard for safe swimming, Todd said. In Provincetown, he's built a 250,000- gallon test facility that will use channels of plants to remove toxic substances from water while raising 500,000 fingerling trout.

Another conference speaker, Frank Hoffman of Calfran International, markets systems that can clean water at the point where pollutants are generated. The systems use a vacuum pump to lower the boiling point of wastewater, then a refrigeration system to condense the steam. (The waste heat from refrigeration is recycled into the boiling process.) What comes out is ultra-pure water and a highly condensed residue that must be disposed of.

In a demonstration for the conference, Hoffman processed a sample from Boston Harbor, and it came out equivalent to bottled water. The company has installations at factories that are now able to keep reusing their own waste water. So far, the largest system Calfran has installed has a capacity of 3,000 gallons per day, but Hoffman is confident that the process is practical for much larger units. He believes that his technology will make for better community choices. People will be able to decide "What kind of development would we like?" instead of "What kind of development do we have enough water for?"—*Susan Lewis* □



Ronald Merrill, '68 (left), and Caltech's Nick Nichols accepting a Presidential Citation on behalf of the Caltech/MIT Enterprise Forum from Association President Emily V. Wade, '45.



(Center, left to right) George Clifford, Denman McNear, and Marty Billett for the Class of '48 Reunion Gift Committee; (Bottom) Hubert E. Knipmeyer, '51, for the MIT Club of Delaware Valley and Charlotte Fraser, '48, for the MIT Club of Rochester.





PHOTOS: KINDRA CLINEFF

CONTINUED FROM PAGE MIT 3

Presidential Citations

Every year a handful of MIT alumnae/i organizations are singled out for outstanding contributions to the Institute during the previous year. Last fall at the Corporation/Alumni Association Awards luncheon six such groups were awarded Presidential Citations for their efforts:

- The Class of 1948 40th Reunion Gift Committee, for raising $6.6 million, more than twice the previous record for a 40th reunion gift;
- The MIT Club of Delaware Valley, for doubling the number of programs offered last year and increasing attendance by 30 percent and club membership by 15 percent;
- The MIT Club of Rochester, for sustained excellence, including an annual spring telethon that serves as a training ground for developing hard-working, MIT-dedicated officers;
- The Caltech/MIT Enterprise Forum, for its creative format, impressive publications effort, and strong group leadership in the four years since its founding as the only joint forum;
- The MIT Enterprise Forum of the Northwest—Technology II Conference, for bringing together major business, political, and educational leaders to address the future economic health of Washington State and its entrepreneurial environment;
- The MIT Club of Washington D.C./Educational Council, for sponsoring a public service program for college-bound students and their parents that provides information on the complexities of financing an education. □

Stock Crash Didn't Hurt

When the Corporation Development Committee held its November 1988 meeting at the Plaza Hotel in New York City, members were treated to a one-day exposure to the richness of MIT's resources. Highlights of the programs were a preview of the report of the MIT Commission on Industrial Productivity and awarding of the 1988 Dalton Bowl to Carl M. Mueller, '41. (More on this award in the April *Technology Review*).

Emily V. Wade, '44, president of the Association of MIT Alumni and Alumnae, filled the CDC in on two of the association's major volunteer-intensive efforts: the class reunion gifts and the Alumni Visit Program. The latter program sends trained volunteers into the field to persuade established donors to upgrade their contributions to the research and teaching enterprises at MIT. By the end of its first year, the Alumni Visit Program had been instrumental in raising the median annual gift from $300 to $500.

Vice-president and Treasurer Glenn P. Strehle, '58, reported that the *Campaign for the future* had reached $330 million. That was about $65 million ahead of where the campaign needed to be at that point in order to reach the goal of $550 million by June 1992.

Strehle noted that the stock market crash seems to have had an impact on donor willingness to make payments on pledges, but not on their willingness to make pledges. In fiscal 1988, gifts to MIT increased by more than 22 %. □

defining the legal constraints, and who are free to come up with creative solutions that meet both the legal and engineering requirements.

I can see the same scenario in community issues: The citizens of a given town do not want a waste treatment plant sited in their area. The traditional engineering approach is to say, "Here's the waste treatment plant that I've designed, and let me convince you that this is a good design." People won't buy it. The engineer of the future has to get excited about spending some time in that community, talking to people. He or she should be asking, "What are the things you don't want, and why? Let's see if together we can gather the facts and then identify a plant design that would be acceptable." That has to be done early in the game. To make that happen, we have to help our students understand that that is not trivial work.

One of the problems we face is that we cannot do the things we want to do in engineering education in four years. To go out on a limb—saying to prospective employers that we don't think we provide adequate training for a practicing engineer with a four-year undergraduate degree—is risky. Students may choose to go elsewhere rather than come to MIT under those circumstances. But who better than MIT to take a leadership role in this process?

If MIT implements the kind of curriculum Engineering Council is talking about, our students will know a little bit less about their chosen technology when they leave here than they do now. But they will have more breadth, a more powerful base, on which to build.

We have to understand what happens to our students in the marketplace. We can't have them come here, pay the enormous cost, and then go out and find they have no value. If we were "Rinky Dink Tech" doing this, we would be signing our death warrant. But industry knows the students we produce; they know MIT's history of leadership. If we produce a more broadly educated engineer, I don't think the marketplace is going to write off our graduates.

What we should be saying to students is that your undergraduate degree is not enough; after you have some experience, you should go back to school. And we should be telling industry that it is in their best interest to allow young engineers to go back to school for a master's degree and to support them while they do so.

This is my view as an individual and as a dean. What we are doing now is talking. We are asking: "Is it true that we need students with a broader base? Is there a need for students to understand more than one discipline in technology? Is there a need for our students to have a different attitude about society and the way technology interacts with it? Do you agree that we should provide more meaningful design experience, synthesis as opposed to analysis? Do you think that we ought to develop methods of teaching students how to deal with complexity, how to deal with large systems? Are these important areas in terms of where you as a faculty member see engineering going?"

If we come to agreement that the answers to these questions are affirmative, I don't see how you could help but come to the conclusion that you can't do this in four years. But that will be up to the faculty. □

UNDER THE DOMES

Default and the Loanly Arts

Have you heard all those horror stories about graduates blithely defaulting on their college loans to the tune of 13 percent per year nationwide? Did it irk you that while you were diligently paying off your own loans, other people were casually dismissing their obligations and thus jeopardizing a system that enabled them to get a good education? Do you sometimes wonder whether you are unwittingly encouraging their irresponsibility by donating to funds that provide loans?

Well, calm down and cheer up—the good news is that of the 30 members of the Consortium on Financing Higher Education (the Ivy League plus others of that caliber), MIT ranks second lowest with a default rate of just under 2 percent. Only Princeton had a lower rate, and the average for COFHE institutions is around 5 percent. Columbia University is at the high end with 10.8 (FY '87 figures).

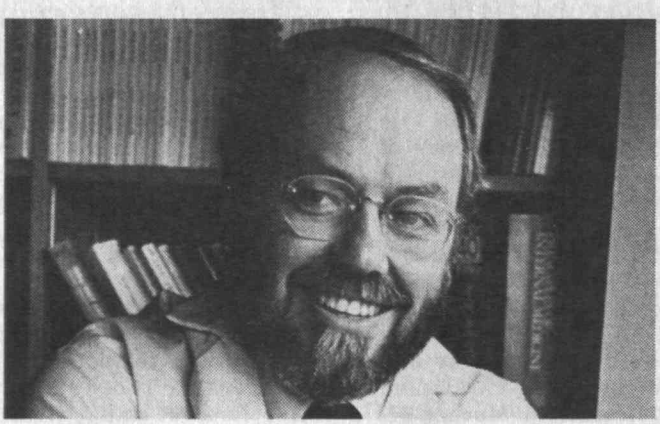
How does MIT accomplish such a feat in a world where schools are not considered seriously in trouble until they have a 20 percent default rate?

It appears to be a combined effort between the MIT Bursar's Office and the type of borrowers they serve. Bursar Shirley Picardi, Ph.D.'76, attributes a good portion of her office's success to responsible alumnae/i who value their educational opportunities. In addition, where some schools may sit back and wait for the money to be sent to them, the MIT Bursar's Office provides comprehensive services aimed at identifying difficulties before they reach the official default stage.

Loans in default are defined as all payments that are more than 120 days overdue. The rate of default is determined by dividing all such overdue active loans by all loans either in repayment or paid in full. The federal government itself was rather slow to tighten up requirements for repayment: for instance, not until November 1987 did a college loan default begin to affect a person's credit rating.

But there are a number of options available to forestall default if a borrower seeks help. The Bursar's Office may exercise discretion arranging loan repayment and hardship deferments with a borrower before a default occurs; once the government is brought in (and it must be notified of default by law) solutions are more difficult to effect.

The MIT Bursar's Office informs all borrowers of the amount borrowed and the monthly payment owed. Their Alumni Services division provides a toll-free phone number (800-537-6012) and receives an average of 130 calls per month for counseling, questions, and problems. Some schools rely solely on collection agencies to handle their errant borrowers; MIT has three full-time collectors who are also well-versed advisors. □



Phillip A. Sharp

Double Honors for Sharp

Within two weeks this past fall, Professor Phillip A. Sharp picked up two of the most prestigious awards in biology and medicine. Sharp, who discovered fundamental information about gene structure in higher organisms, won both the 1988 Albert Lasker Basic Medical Research Award and the 1988 Louisa Gross Horwitz Prize.

Sharp shared both prizes with Professor Thomas R. Cech of the University of Colorado at Boulder, an MIT postdoctoral researcher from 1975 to 1977. Both professors' discoveries advanced evolutionary theories about the origin of biological systems.

As reported in *Tech Talk*, the American medical community generally considers the Lasker award to follow the Nobel Prize in importance. And more than half the previous Horwitz winners have gone on to receive Nobels.

In the late 1970s, Sharp discovered that nucleated cells—which exist in higher organisms—have within their genes segments of DNA that apparently lack hereditary information. After the DNA is copied into a complementary strand of RNA, the cell's machinery removes the "nonsense" segments in the RNA. The remaining RNA segments are then joined together and translated into proteins.

The discovery of meaningless segments within genes was "perhaps the most unanticipated observation in molecular biology, with implications for the evolutionary origins of genes," according to Pierre Chambon, professor of biochemistry at the Institute de Chimie Biologique in Strasbourg, France. Sharp's findings indicate that higher organisms probably did not evolve from non-nucleated bacteria similar to the blue-green algae existing today. These bacteria do not have nonsense segments of DNA or RNA.

Sharp's and Cech's work is also proving important in understanding the development of cancer and other diseases. For example, AIDS and other viruses "utilize RNA splicing to carry out their replication in cells," Sharp says.

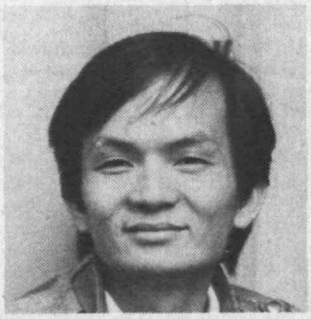
Sharp, 44, came to MIT as an associate professor in the Department of Biology and Center for Cancer Research in 1974 and became a professor in 1979. In addition to heading the Center since 1985, he teaches courses on animal virology and cell biology. □

PHOTOS: DONNA COVENEY, L. BARRY HETHERINGTON

DomeBits

THE DEGREE CHAMP

Tue Nguyen, '84, a 26-year-old Vietnamese-born student who came to the United States nine years ago as a boat person unable to speak English, has met the requirements for his seventh degree from MIT, a Ph.D. in nuclear engineering. As far as anyone can tell, earning five bachelor's degrees (in physics, computer science and engineering, electrical engineering, mathematics, and nuclear engineering), one master's degree (in nuclear engineering), and the doctorate makes Nguyen the holder of more MIT degrees than any other graduate. Nguyen arrived at MIT from a Pasadena, Tex., junior college in 1981, and proceeded to take tremendous course loads on the way to five undergraduate degrees in four years. One semester he took 12 classes, more than double the normal semester load of four or five subjects. He also found time to play table tennis and badminton, to study Chinese at Harvard in preparation for communicating with his fiancee's Chinese-speaking family, and to work on projects at IBM and the Argonne National Laboratory while in graduate school. Nguyen started work at IBM in December, designing new technology for the manufacture of semiconductor devices. One of his brothers, Tien Nguyen, S.M. '87, is also a candidate for a doctorate in nuclear engineering at MIT. □



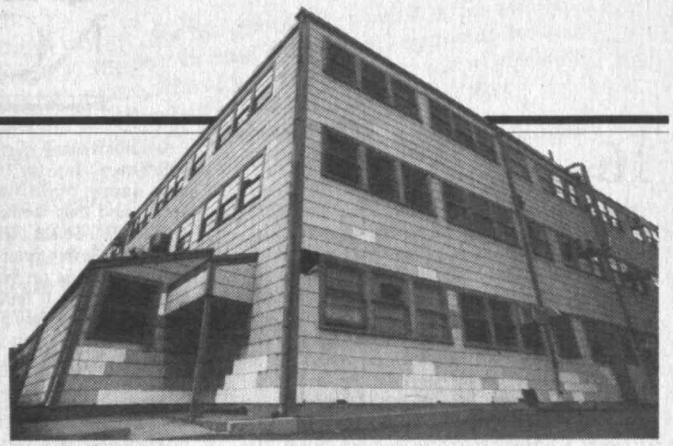
Tue Nguyen

"THE" VIRUS

About 10 percent of the 2,000 MIT computers connected to the Internet network were infected with the computer virus—created by a Cornell graduate student—that swept the country in early November. As reported by Eugene Mallove, '67, in *Tech Talk*, Professor James D. Bruce, Sc.D.'64, vice president for information systems, gave a campus news conference attended by dozens of reporters to shed some light on what happened nationwide and at MIT. The virus had the most impact at the Artificial Intelligence Laboratory and the Media Lab, but did not invade the Project Athena student network. MIT took its infected machines off the network until it cleaned up the bugs in the electronic mail programs that allowed the virus to spread. What was lost was hours of computer time and people time spent wrestling with the problem, but it could have been much more serious if the virus' creator had intended to damage files. Bruce pointed out that the programmer made an error in his code so that a command in the virus to test whether a machine was already infected failed. "This led to the machine having many copies of the virus running simultaneously. This used up large amounts of computer time, which caused the legitimate user to experience sluggish performance in his or her machine" and led to the relatively rapid discovery that the virus was at work, Bruce said. He advises computer users to change their passwords to something unique—a word not in the dictionary—and back up their files to protect against infection by a virus and consequent loss of files. □

NEW FACES AT 2.70

The 2.70 competition has entered a new era: For the first time in 17 years, the famous design course was not guided by the legendary Woodie Flowers, Ph.D.'73, professor of mechanical engineering. This year, Assistant Professor Harry West, Ph.D. '86, headed a team of 14 faculty members and two teaching assistants, working with the largest group ever to take 2.70—237 students. The 1988 contest was notable for its three-way competition, a change from the two-way combat of previous years. A Japanese company filmed the event for television broadcast to a projected audience of 20 million.□



A piece of history whose days are numbered: Building 20.

DAYS NUMBERED FOR BUILDING 20

It is time for someone to organize a retirement party for Building 20—maybe a reunion of its habitues, a retrospective of its lifetime achievements? The crumbling wooden frame building has had a rich life following its construction during World War II as "temporary" housing for the Radiation Laboratory (Rad Lab to its friends), where radar was developed. The Institute's first interdisciplinary laboratories were later hatched in Building 20, moving as they grew into larger, more imposing quarters. Jerry Lettvin, professor of electrical engineering and biology, held court in a Building 20 lab for years. But now its days are numbered. It sits on part of a large parcel of land opened up when MIT bought and then leveled the TRW building on Ames Street. An MIT committee is looking at who works in the building, what their work entails, and how much space they will need if relocated. At the same time,the MIT Planning Office is involved in a study of how the entire TRW-Building 20 land will be developed. □



CLASS NOTES

16

We regret that our only news is the passing of beloved classmates: on August 8, 1988, **Elbridge R. Devine** of Pelham, N.Y.; on October 31, 1988, **J. Douglas Robertson** of Taunton, Mass.; on November 3, 1988, **Isidor Richmond** of Brookline, Mass. I'm grateful that I had the good fortune and pleasure of sharing reunions and many personal conversations in recent years with each one of them. Three different personalities, but each uniquely wonderful. May they rest in peace.

Izzy became a navy pilot in World War I and served as a lieutenant commander in World War II when he headed the navy's air station in Bahia, Brazil. He maintained his pilot's license into his early 80s and regularly brought a plane to the reunions to provide scenic flights for his classmates. Elbridge and Izzy attended our 70th reunion, which was one of the very few that Doug missed. From the obituary we note that "Mr. Richmond won a Rotch Traveling Scholarship in 1923, which enabled him to study for two years at the Ecole Des Beaux Arts in Paris and the American Academy in Rome. He and his partner, Carney Goldberg, received the Boston Society of Architects' Harleston Parker Medal in 1949 for their design of Temple Emeth in Brookline. Among Mr. Richmond's legacies are Hingham District Court, the Brighton Post Office, Temple Emmanuel in Newton, Thoburn College in Lucknow, India, and the Newtowne Court Public Housing Project in Cambridge. He served as president of the Boston Architectural Club in 1931 and the Boston Architectural Center from 1952 through 1955. He was also president of the Boston Society of Architects, a fellow of the American Institute of Architects, and served on a commission to preserve the historical and artistic integrity of Beacon Hill."

We extend our heartfelt sympathy to the families of these great men.—**Bob O''Brien,** Acting Secretary, 25 Keith Rd., Pocasset, MA 02559

17

Enos Curtin, in a note penned November 5, was the first to respond to my plea for word from the class. Enos spent a lot of time working as a volunteer with the American Field Service. He first connected with AFS in December 1914, and a month later left MIT to drive ambulances in France. He returned to the Institute for a year and then enlisted in the U.S. Army, serving in France in the Artillary Corps. Some years ago he belatedly received a Certificate of Honorary Citizenship of the City of Verdon, where he had served with a French battery during the fierce German offensive of early 1916. Classmates will recall this was the longest, bloodiest battle of World War I, in which 1 million were killed. (What Enos did not include in his modest letter but which I learned from MIT records is that he was convinced Tech should be represented by an ambulance unit, so he initiated funding to equip an ambulance.)

As Enos writes, "Between wars I struggled on Wall Street." In May 1942 he went back into the army during World War II and served in England, Africa, and Italy through October 1944, then went back to Wall Street. His service as captain in World War I, lieutenant colonel in World War II, and his struggle on Wall Street between wars and after World War II must have caught someone's attention, for he was asked to help out for a few weeks in Washington with the Marshall Plan. The few weeks turned into two years, and he became director of operations. He also undertook a couple of short assignments for other government agencies.

Enos writes that he does a little work for a hospital and three organizations for the blind, but otherwise "I take it easy." What he omitted is that he was named honorary chairman of the National Society for Prevention of Blindness, Inc.

During an Alumni Fund telethon I called **Al Ferretti.** Al has been living alone since his wife passed away 10 years ago. The night I called he had just had a doctor's appointment. It seems that a year ago he had been attacked at home and beaten unconscious by an intruder looking for money for drugs. Needless to say he was hospitalized. His eyesight is still affected, so no driving and still some difficulty reading. Otherwise, "no complaints."

That's the news for this month. Don't forget: if any of you have news but find it easier to telephone than write, just call (617) 237-9378.—**Don Severance,** Acting Secretary, 39 Hampshire Rd., Wellesley, MA 92181

18

At a recent meeting of the American Technion Society, I had a conversation with **Eli Berman,** who was getting ready to leave in December for a vacation in California. The speaker for this occasion was MIT Professor Edward Roberts, who talked about technological development along Route 128 and compared it to what is going on in this innovative area in Israel.

Your secretary is very happy with the development of the Boston seminar lecture program started by our class. The first meeting was held on November 7 and was attended by over 200 MIT alumni and spouses. A most interesting lecture was given by Ann Friedlaender, dean of the School of Humanities and Social Sciences, on the U.S. national debt.—**Max Seltzer,** Secretary, 865 Central Ave., Needham, MA 02192; **Leonard I. Levine,** Assistant Secretary, 519 Washington St., Brookline, MA 02146

19

Barbara and **Don Way** sent us a postcard picturing Chatham Bar. We recall with pleasure the two class reunions we enjoyed there at the Chatham Bar Inn.

Russell Palmer is in a nursing home on Cape Cod. We received a letter from his devoted sister, Mrs. Charles N. Borden, advising us that she makes many visits there and he is doing very well.

We regret to report the death of **Arnold B. Staubach,** on September 28, 1988. He graduated in Course IV.—**W.O. Langille,** Secretary, P.O. Box 144, Gladstone, NJ 07934

21

Our January column reported the death of **Donald G. Morse.** After the deadline for that issue, I received a letter from **Leo Pelkus** and an enclosed clipping, which provided additional information about Don. He graduated from Roxbury Latin School in 1917, and (in addition to MIT) attended Dartmouth College, where he was an honorary member of the class of 1921. He served in the U.S. Naval Reserve from 1919 to 1921. Don was a senior partner in the James F. Morse Co., a rendering firm in Boston that produced tallow.

Leo says, "During the last ten years, Don and I got together often for lunches and dinners at his house and mine (frequently with **Ed MacDonald** and **Frank Whelan).** I shall miss him greatly."—**Sumner Hayward,** Secretary, Wellspring House E64, Washington Ave. Ext., Albany, NY 12202; and **Samuel E. Lunden,** Assistant Secretary, 6205 Via Colinita, Rancho Palos Verdes, CA 90274

22

Charles Hall Baker, Course XV, age 90, of 20 Lawson Rd., Cape Elizabeth, Maine, died October 13, 1988, in a Portland hospital after a long illness. Hall was a retired real estate broker and former chairman of the Maine Real Estate Commission. He entered Tech as sophomore after a year at the University of Maine. Over the years he was in regular attendence at our five-year reunions and the annual Alumni Days. He was a U.S. Navy veteran of World War I and a member of the Beta Theta Pi fraternity. His wife, Florence, died in 1969. He is survived by his brother, a daughter, two grandsons and two great granddaughters. Hall was a longtime close personal friend. I might describe him as the complete gentleman, ever thoughtful of others.

Kohei Kagami, Course II, died last May in Tokyo, Japan. A note from his daughter to the Alumni Association says in part, "Thank you very much for sending the magazines, (the *Review*) which Mr. Kagami enjoyed so much reading." The 1961 Alumni Register indicates that at that time he was director of Mitsubishi Nippon Heavy Industries, Ltd. in Tokyo. . . . **F. Reed Dallye,** Course VI, died June 25, 1987, at age 86 in Newport Beach, Calif. He had been retired for many years. The 1961 Register shows him to have been the division manager of accessory sales of Alcoa in Pittsburgh. We have no information of survivors.

Charles George Dandrow, Course IX-B died in Jacksonville Beach, Fla., on August 9, 1988 at age 88. As all of our class knows, George was one of our most outstanding members. Suffice it to say from my personal recollection, George was a suc-

cess at everything he turned his hand to. Hammer thrower on the 1920 Olympic team, president of the Alumni Association in 1948-49, vice-president and general manager of the Johns Manville Sales Corp. before retiring in 1944, industrial marketing consultant following his retirement, recipient of the Bronze Beaver. George's first wife, Helen Alquist Maguire whom he married in 1928, died in 1961. His second marriage to Catherine Dandrow ended in divorce. He is survived by a daughter, a son, a step-son, a sister, and many grandchildren and great-grandchildren.

George S. Holdnerness, Course VI, died September 10, 1988, in Bronxville, N.Y., in his 92nd year. He came to MIT as a sophomore after earlier studies at Vanderbilt University. Until his retirement, he was a partner in the architectural firm of Eggers and Higgins in New York. No record is available of any survivors.

Some news from the living would be helpful for next months notes. Best wishes for the coming spring to all you hearty long lasting classmates.—**Yardley Chittick,** Secretary, Box 390, Ossipee, NH 03864

23

As I sit down to make this report, the leaves are falling almost like a yellow snow. The temperature is a cool 50 degrees. It's October 31st, Halloween, and the kids will be at the door to collect their annual dues, decked out in all sorts of costumes and singing songs.

I have to report three deaths of our class members, and one widow. Mrs. Ethel Hendrie, late wife of **Robert E. Hendrie,** died in July, 1982, and apparently left no relatives. Robert Hendrie may be remembered as an outstanding track man at the Institute.

Pierre F. de Paynier died on July 22, 1988. He wasa member of our class, and was born in Switzerland, coming to this country in 1918 after studying at the Zurich Polytechnique. He studied naval architecture at the Institute. After leaving the Institute he worked first with the Worthington Pump and Machinery Corp., and then for a shipbuilding company, and finally retiring as senior project engineer for the Texaco Engineering Department. He lived in Arizona and spent much time exploring the wonders of that state.

Bernard Flynn died on August 15, 1988. He was a member of our class and attended Boston Latin High School and the Huntington School before entering the Institute. While at the Institute he studied chemical engineering administration. After leaving the Institute he moved to Mexico where he became an operator dealing in oil. He later moved to the west coast, living in Los Angeles, and became president of the Pacific Soap Co. He married Miriam Rosalie Thomas of Chicago and had a family of 12 children. In later years he sold the soap business and became a major land-owner in northern California. During this time he established a number of scholarships for needy students and helped a great number of needy persons, including many Mexicans and Vietnamese. He is survived by 11 children, 34 grandchildren, and two great-grandchildren.—**Fred Almquist,** Secretary, 63 Wells Farm Dr., Wethersfield, CT 06109

24 65th Reunion

*Editor's note: As we went to press, we received word from Katharine Hereford that her husband and your class secretary, **Rockwell Hereford,** died November 26 in Carmel, Calif. Prior to retirement, he was involved in administrative planning for U.S. Steel Corp. and was vice-president of the International Congress of Industrial Editors. See box this page for an excerpt from a letter written by his son, David, in memory of his father. We wish to express sympathy to the family.*

Everett R. Leroy passed away June 4 of pneumonia in St. Lukes Hospital in his home city of New York. He graduated as an electrical engineer. He had been vice-president of Teleregister Corp. at Chambers St. in the city. He is survived by his wife Lucille at 639 W. 173rd St., New York, NY 10032.

Advice was received of the death of **Richard D. Jackson** of Tampa, Fla. He had an active life in his home town area. He had served as president of Jackson Grain Co. and X-Cel Stores and served on many boards of directors including Southern Railroad Co., Grain and Feed Dealers Assn., Penninsular Tel Co., First National Bank of Tampa, and the Florida State Fair Association.

A double loss to the class of 1924 is the death of the long-serving class secretary **Russell W. Ambach.** He was born in 1901 at Woonsocket, R.I. He attended Woonsocket High School where he was a scholar and athlete. He led his high school to the state interscholastic track championship in 1920 by winning 28 of the 47 team points in five events. He was also on the all-state football team.

Russ, in his senior year at MIT, was captain of the MIT Track Team. He graduated as a civil engineer and had an unusually varied career. In 1930 he spent 7 months as a consulting engineer on coal mining in the Soviet Union and published some articles on Russia. He joined the Atlantic Refining Co. in Providence, R.I. in 1935. During World War II, Russ designed and tested fuel injection engines for B-29 airplanes. He retired from Atlantic Refining Co. in 1966.

Russ was generous of his time not only for the class but for his church and for the Boy Scouts. He served as a member of the Brookline Zoning Board of Appeals for 11 years and was a trustee of the Harvard Church and the Carriage House Condominium.

The move from his retirement home, being converted to apartments, to a new one, proved too much for Russ' delicate health. He is survived by two sons, Dwight R. of Chevy Chase, Md., and Gordon M. of Washington, D.C.; and six grandchildren.—**Rock Hereford,** Acting Secretary, Hacienda Carmel, #90, Carmel, CA 93921-5397,

Rockwell Hereford, '24, Remembered by His Son

November 30, 1988

Dear Dad,

A final note to thank you . . . for the gift of life, a spirit of adventure, an example of integrity, support in time of need and opportunity, and especially for taking the time, lots of time, to show me the world as it was, is, and might be. You lived a very full and productive life:

- Son of a lawman in the best Old West tradition;
- Raised in Arizona where you climbed every mountain and won the respect of all who knew you;
- A champion wrestler in college, who took on all comers with few losses and sadly turned down a top spot on the U.S. Olympic team to get your MIT degree;
- A soldier commanding artillery;
- An engineer who helped build the dams of the Sierra, the Liberty Transport ships of World War II, and the great gas pipelines spanning the U.S. and the Middle East;
- Editor and leader in employee communications;
- Scholar, writer, and expert on Western history;
- Photographer and artist who recorded the best of the West on film and canvas.

You loved the outdoors. Nature was your bible, and as Charles Russell said of the American Indians, "You knew every page." Your three favorite heroes were Teddy Roosevelt, Herbert Hoover, and Henry M. Robinson—all men like yourself of great courage, character, and innovation. When you gave your word, no document was necessary. You once told me that you wanted written on your gravestone, "Here lies a man of character." In Japan, when a man of your character dies they say, "He entered another room." You will be welcomed there and well prepared for the new adventures of mind and body, spirit and friendship. We look forward to seeing you there. Thanks, with much love.

Your son, Dave

25

Elinor and **Sam Spiker** spent part of last summer travelling. They took a four week trip to Alaska and the Canadian Rockies.

Since the last class notes were prepared more information about **Morrough P. O'Brien** has been received. A building on the University of California Berkeley campus that houses the hydraulic

engineering laboratory and the water resource center archives is named O'Brien Hall in Mique's honor. The American Shore and Beach Preservation Association will establish an award in his honor to recognize outstanding achievements in the field. Mique is survived by his wife Mary, a son and a daughter.

The passing of two classmates must be reported. **H. Wesley Leavenworth, Sr.,** died in Waterbury, Conn., on May 19, 1988. He had retired as vice-president and general manager of the Oakville Pin Division of the Scovill Manufacturing Co. Following his retirement from Scovill, he was president and general manager of the Turner & Seymour Manufacturing Co. in Torrington, Conn., for over three years. Besides his wife Dorothy, Wesley is survived by two sons, a daughter, six grandchildren and three great-garndchildren.

Chester H. Hosmer died on June 8, 1988, in Modesto, Calif.—**F. Leroy (Doc) Foster,** Secretary, 434 Old Comers Rd., P.O. Box 331, North Chatham, MA 02650

26

The Charles Stark Draper laboratory of Cambridge has endowed a major new International Award for Achievement in Engineering and Technology, consisting of a Gold Medal and $350,000 in prize money, awarded bi-annually, reports Robert N. White, President of the National Academy of Engineers. They are looking for the kind of basic knowledge like the navigation systems research of **Charles Stark Draper.** "The Space Shuttle, *Discovery,* carried a computerized internal guidance system that will automatically guide it to the correct orbit, and will direct the craft safely back to Edwards Air Force Bace." We certainly are proud of Stark who created it.

Edward R. Huckman's wife, Eleanor, died after 59 years of marriage on October 4, 1988. I know what a loss that is, but after 15 years of my present marriage, I certainly recommend marriage again. Eleanor and Ed went regularly to reunions, so she will be a loss to those who knew her. . . . **Morris L. Minsk** called. He is in a Chelsea, Mass., Jewish nursing home. He is quite well and has some nephews, almost all doctors. His telephone is (617) 884-3036, and I'm sure he would like to talk with you.

Gilbert C. Delvaille of Riverdale, Calif., died September 7, 1988, leaving his wife, Lorrain, two sons, and five grandchildren. He was executive vice-president for 43 years for the Southern California Electric Co. Gilbert was born in Paris, France. **Bruce Powers** sent a clipping and a letter outlining their relationship. They both went to Southern Sierra Power Co. as "students in courses where we spent a year and a half, working for a time in every department of the company, rooming together until Gilbert got married and stayed on until at a young age, he was made vice-president, while I took off for a more lucrative motion picture industry."

Rexford A. Bristol of Foxboro, Mass., died September 13, 1988. He graduated from Amherst before coming to Tech. Rex was president and chairman of the Foxboro Company. He leaves his wife, Margaret, three daughters, three sisters, five grandchildren and two great grandsons. He was owner of Sullivan Stadium in Foxboro and connects with many organizations. Shortly before I knew of his death, I though of calling him to write about his annual fishing trips to Labrador. . . . **Carl N. Pratt,** formerly of Delray Beach, Fla., died in Greenfield, Mass., on August 31, 1988. He was a registered architect. . . . **Ralph E. Calclesser** died September 28, 1988. He had retired from General Electric where he was superintendent of Locomotive Mfg. Co. in Erie, Pa. . . . **Robert E. Ellis** of Ashville, N.C., died August 24, 1988. His parents lived in Cuba until he was 14 years old but he was born in New Orleans, La. He was a construction engineer and also worked a number of places outside the United States. . . . **Morton P. Woodason** died September 17, 1988. He lived in Sharon and was in World War II and Korea. He was a captain in the Navy and could repair airplanes in the Philippines and was an able yachtsman. He was manager of manufacturing for Foxboro Co. . . . **George B. Torren** of Shewsbury, Mass., died November 2, 1987. George was chief engineer of Tucker and Rice in Worcester prior to retiring.—**Donald S. Cunningham,** Secretary, 27 Lowell St., Braintree, MA 02154

27

Enjoyed an overnight visit with **Larry Grew** and Lillian at their comfortable home in Branford, Conn. Larry has recovered well from his bypass surgery last March. They have three organs in their lower-floor suite—two ancient ones with foot pumpers and a gorgeous Yamaha orchestra electric with two keyboards and foot pedals. Larry has all his tools hanging in orderly fashion in his garage. Still a well-organized engineer.

Visited with **Lee McCanne** and Martha at their Shore Rd. home in Old Lyme, Conn. On a hot day last August, Lee collapsed alighting from his car. An ambulance took him to a clinic and to a New London hospital while he was unconscious. Upon the advice of five doctors, he was operated on for a bleeding ulcer. After receiving nine transfusions, Lee is gradually regaining his strength. Martha and Lee probably have the largest family in our class combining two marriages: six children and 21 grandchildren.

Received a letter from **Elwood Church** and wife Elinor, now of Brattleboro, Vt. A course VI-A engineer from Alberta, Canada, Elwood started with Boston Edison and worked there his entire career. He was in charge of system planning the last five years before retiring in 1968. "I married my second wife, Florence, in 1945 and we lived happily in Marblehead, Mass., for 30 years, keeping busy with town and church activities. She died in 1976. Her emphysema finally caught up with her.

"My present wife, Elinor, who some of you have met at our 1982 and 1987 reunions, now commutes with me between our two homes, hers in Brattleboro and mine in Seminole, Fla. We spend much of our time with church activities, one of which is calling on sick or disabled people."

Chungsoo Oh died August 5 in Seoul, Korea. A letter from his grandson, Edwin M. Oh, '84, reads: "After graduating from MIT, he returned to Korea where he started and managed several businesses until the Korean war. Following the war, he served on the cabinet of the Republic of Korea interim government as minister of commerce and industry and later as minister of communication." We recall talking with him when he attended our 50th and 55th reunions. At the time he was chairman of the Korean Trade Development Co., which he founded upon leaving government service. He retired in 1984 after successfully establishing a huge trade of products with the U.S. and free world. He was also a founder of the MIT Club of Seoul.

Herbert G. Johnson died April 2 in West Chester, Pa. He suffered a fatal heart attack while on a business trip in Hamden, Conn. He was an active consultant for his company, Johnson Engineering, in Spring City, Pa. A member of his family wrote: "We all are aware Herbert was very proud of MIT and its superb academic program."

Doria G. LeTourneau died August 25 in Plainfield, N.J., following a long illness. A course I civil engineer, he participated in building the highway bridges in Bucksport and across Eggemoggin Reach to Deer Island, Maine. During the war he spent two years at Oak Ridge on construction of the atomic plant, and worked on the Manhattan Project. In 1952 he was civil engineer with S.J. Groves Construction Co. and he became chief engineer of Sam Braen Construction Co. in 1967 before retirement.

Walter G. Walker died August 23 in Newport News, Va. He retired from the NASA Langley Aeronautical Laboratory at Newport News in 1966 after 40 years as an aerospace technologist. He became active in the National Association of Retired Civil Employees and liked to travel. His best hobby was being an amateur radio operator for station W4AKN for over 60 years! **Chuck Pope** in San Francisco was one his many nationwide friendly hams.

Herman T. Barker died September 9 in East Walpole, Mass. He attended Dartmouth and was a grad student in our class. In 1967 he was chief chemist at the Paper Division of Bird & Sons Co., and was a member of the American Chemical Society and Technical Association of the Pulp & Paper Industry.

Charles A. Sanborn died September 17 in a nursing home in Kittery, Maine. His home was in Kingston, Mass., where his wife died in 1986. He obtained a master's degree in administration from New York University in 1949. Living in Ossining, N.Y., for many years, Charley was a licensed professional engineer for the New York Regional Postal Service from 1935 until his retirement to West Yarmouth, Mass., in 1971. He was an active Mason who held many high positions. He was also a radio ham, a charter member of the MIT Club of Cape Cod and the Bass River Golf Club, and a life member of IEEE. He was on the board of directors of the Cape Chapter of the American Diabetes Association, and was a long-time member of the First Baptist Church of Hyannis.

Louis Brega died December 26, 1987, in Poughkeepsie, N.Y. A mechanical engineer, he had worked in construction and maintenance before joining the Corps of Engineers as a first lieutenant in 1942. He became chief engineer of the Boston army base and then executive officer of the First Service Command area between 1945 and 1946, attaining the rank of major before his discharge. From 1948 to 1954, Louis was superintendent of buildings and grounds at Rhode Island Hospital. From 1954 to 1968, he was general manager of buildings and grounds at Vassar College. During that time, a new residence hall, foreign-language building, and faculty housing were constructed, and the college library underwent extensive reconstruction. Upon retirement, Louis said he looked forward to doing many things he had long postponed.

Our deep sympathy is extended to the widows and families of these classmates.—**Joseph C. Burley,** Secretary, RFD 1, Epping, NH 03042; **Lawrence B. Grew,** Assistant Secretary, 21 Yowago Ave., Branford, CT 06405

28

It was a great pleasure to have a good newsy letter from **Gil Toone.** He is still recovering from the effects of the pneumonia he suffered in July 1987. This, in addition to a 15-year history of heart problems, keeps him somewhat in check. Wife Isabel is well except for a few aches. Despite his impairments, Gil still raises a lot of gladioli, dahlias, roses, and other flowers. To the Toones we send our hearty, if belated, congratulations on the advent of their first grandchild on Good Friday 1987. They wonder if this is a '28 record? We also learned from Gil that Ethel (Mrs. **Carl J.) Bernhardt,** after a period of illness, had moved into a nursing home. Gil and Isabel paid her a visit there recently.

We have a letter from **Nap LaCroix** in which he compares the 1988 class reunion picture with that of 1983 and believes he can see "the hand of time." In spite of this, he thinks some classmates are holding up remarkable well. As for himself, Nap says "Although many tell me how well I look, don't you believe it." He and Gertrude had thought of spending winters in a Caribbean environment but now feel they must abandon that idea.

Some classmates made deposits for the 60th, then had to cancel. To these, items of

memorabilia were sent, which prompted a few replies. Of such were Olive and **Newt Foster.** The principal benefit of their thank-you note was to let us know they are both well and responsive. . . . A formal invitation came to us from Allece (Mrs. **Tom) Garrard** to attend the dedication of the Garrard Ardeneum Garden Museum. This event will mark the approaching centennial of the University of Oklahoma in 1990. The ardeneum features a collection relating to the University's distinguished quarterly literary journal *Today.* Thoughtfully, Allece sent us a copy of the journal. The word "ardeneum" was introduced into the language by Allece. It is derived from the contraction of "garden" and "museum." Allece is busy and productive in all her several projects; we heartily applaud her industry and accomplishments.

We were pleased to have a letter from **George Palo** but greatly saddened by the message it contained. George had been in touch with **Hal Porter** and learned that Hal's wife, Madeline Dietrich Porter, died October 12, 1988. This came as something of a jolt since the Porters were both with us only four months earlier at the class reunion. The Porters have a son, a daughter, and three granddaughters. Madeline was an artist and also had an interest in genealogy. Researches in the latter showed her family ancestry leading back to the Ostrogothic King Dietrich von Bern in the period of A.D. 454-526.

With regret we must report also upon the deaths of two classmates. **Robert W. Carder** died August 21, 1988, after a long illness. The information was provided to the Alumni Office by a cousin. Bob graduated in Course 10, chemical engineering, then earned his master's degree in the practice school of that department. His professional career was in petroleum refining, mostly with Standard Vacuum Oil Co. in New York and with Mobil East, Inc., New York. He retired from the latter in 1966. His other interests were in the areas of history, genealogy, and biography. He served as president or governor of several local societies related to these fields. Bob's wife, Ruth, predeceased him. . . . **Donald T. Hall** died July 23, 1988. The report came from his daughter, Janet. Donald's undergraduate career was in Course 15, business and engineering administration. Throughout his life he remained in his native Hawaii, retiring in 1966 as vice-president and manager of Honolulu Iron Works. . . . To the families of each of these departed friends we extend our heartfelt sympathy.—**Walter J. Smith,** Secretary, 37 Dix St., Winchester, MA 01890; **Ernest H. Knight,** Assistant Secretary, Raymond, ME 04071

29 60th Reunion

Mary and **Frank Mead** are still living in the best of two worlds: Marion, Mass., from May 15 to October 15 and Northport, Fla., the rest of the time. They have held membership in the Kellansett Club in Marion and the Northport City Club in Florida for decades. Mary had been playing golf regularly until last summer, when she had two hernia operations and a bad case of shingles, so she has given up golf. Frank still plays four days a week. As our age advances, we give up some of the rigorous activities, and Frank has given up his ten lobster pots so as to have more time for his vegetable and flower garden and fishing for salmon and bluefish in New Brunswick.

Thomas W. McCue of Newton Highlands, Mass., writes, "I have recently graduated from B.C., class of 1988, with a degree in science and law. Since my tuition was $2,000 a semester, I decided to study biology on my own. I am involved in politics, travel, and during the summer I go to the beach and enjoy the children.". . .**Amasa G. Smith** of Birmingham, Ala., writes, "I see **Larry Luey** of Birmingham, Ala., several times a year. He and his wife are well and doing fine. As for me, age slows all of us, but I still am involved with boards of the Boy Scouts, YMCA, Red Cross, and with the Food Bank as president. The Food Bank will give four-and-a-half million pounds of food for the poor this year. Birmingham is very busy with low unemployment. Sorry we will not be able to make the 60th reunion next year. We would have enjoyed seeing you and others once again. Best regards to all.". . .**Adrian "Cub" Clark** of Woodbury, Conn., says that he and his wife, Hope, had a poor summer: both had a bad case of bronchitis, and Cub had laser surgery in his right eye. "We are lucky just the same. We keep busy and smiling."

William W. Saunders of Naples, Fla., writes, "Our permanent residence is still in Naples, but we are building a house in Hendersonville, N.C., and sold our house on Lake Winnepesaukee in New Hampshire. In due course of time, we may change our permanent address to North Carolina." Bill's hobbies include golf, fishing, and radio-controlled model sailboats. . . .**Eric A. Bianche** of Tequesta, Fla., writes, "At age 82, I have few complaints, healthwise or otherwise. For that I am grateful. We do plan to get to the 60th reunion next June assuming that all goes well to that time. We spent two-and-a-half months this past summer at Eastman Properties in Grantham, N.H., enjoying the climate and the golf course. This was our third summer at Eastman, and we expect to repeat in 1989. This past year we traveled to the West Coast, spending the Christmas holidays in Pasadena with my son and family. Then we drove up the coast to San Francisco for a brief stay at the St. Francis. Otherwise, we have been here in Florida except for the respite from the summer heat in the hills of New Hampshire. Our best wishes to all." Eric's hobbies include golf and gardening.

Rolf A. Zurwelle of Forest Hill, Md., writes, "I am a 'conceptionist' (anti-abortion). Consequently, my age is 82 years and nine months. Life begins when the elements of the father and mother become a cell to which God at once gives life. I continue research of gravity, the atom, and especially the neutron, of which so little is known. My studies suggest it is bipolar. By the grace of God, my client continues to give me two or three small research jobs concerning the use of magnetics and electrophoresis. I keep up to date on all new production advances and all improvements in design to assure quality products. I believe that our science and engineering capabilities should not be spent on space efforts but rather used to clean up water, air, and soil, to create better housing at lower costs, and to solve the battery capacity for the electric automobile."

Your secretary would like to report that he, his wife Helen, and a few relatives finally took a long-awaited trip to London, England, for ten glorious days. We saw such historic places as the Westminster Abbey, Royal Albert Hall, and the indoor amphitheater with a capacity of 8,000 seats, the marvels of ancient Stonehenge, the Tower of London, and the ruins of the Roman baths while visiting Salisbury Cathedral, a magnificent 12th-century structure. We went through such familiar places as Exeter, Amesbury, and other towns, which also exist in our backyard in New Hampshire. Remembering what my friend and classmate wrote in one of his letters, when visiting London, that he never fails to buy a pair of shoes from a firm on Cork Street, my cousin and I found the place. Each of us bought two pairs of hand-crafted shoes. I am waiting to wear one pair on a historic occasion, our 60th reunion.

I regret to announce the following class-related deaths: **Charles Frank, Jr.** on March 9, 1988; Mrs. **G. Ridgley McDaniel** on August 4, 1988; Mrs. **Marshall S. David** on August 19, 1988; and **Charles W. Sampson** on September 17, 1988.—**Karnig S. Dinjian,** Secretary, P.O. Box 83, Arlington, MA 02174

30

This month's items have been gleaned from the comments you sent to MIT at the time you placed an order for the new Alumni Register. As previously reported, **Hank Halberg** worked for many years as a hydraulic engineer for the U.S. Geological Survey in Little Rock, Ark. He made studies of and wrote reports on ground water resources, not only in Arkansas but also in Albany and Utica, N.Y.; Providence, R.I.; and the greater Boston area. He and his wife Edith are dedicated bird watchers, active members of the National Audubon Society and have made extensive bird-watching trips through Central America. In recent years he has devoted an increasing amount of time to church work as treasurer of Trinity Episcopal Cathedral of Little Rock and a member of the hospital visitation group. . . . **Morell (Hijo) Marean** reports from Boynton Beach, Fla., that at age 80 he has just started a business to help his peers "with problems in connection with Medicare and health insurance claims."

Howard Robinson's eight years in the diplomatic service as attache at the American Embassy in Stockholm and as special assistant to the ambassador in Paris, as well as his chairmanship of the physics department at Adelphi University in Garden City, N.Y., were mentioned in the November 1980 Notes. His latest report contains additional items of interest. He and his wife Kira Volkoff Robinson met while they were post-doctoral students at the University of Uppsala and have maintained their student friendships. In 1986 they spent a month in Sweden celebrating their 50th wedding and 50th anniversary of their "first sojourn in that wonderful country." Howard has written or edited numerous publications including articles on the structure of glass and on spectroscopy and a book on high polymer physics while chairman of the High Polymer Division of the American Physical Society. He has also edited, in collaboration with his wife, a translation of eight volumes on lecture demonstrations in physics as given at the University of Moscow. Since 1966 he has served as editor of the State Optical Institute of Leningrad.

Tony Savina is a past president of the MIT Club of Fairfield County, (Conn.) and a club director, as well as a director of the Stamford Historical Society and the Stamford Forum for World Affairs. He is also a member of the steering committee and a "topic coordinator" of the "Institute for Retired People," a self-learning, continuing education program at the University of Connecticut, Stamford campus. . . . **Morris Young** is still a consultant in ophthalmology at St. Vincent's and Beth Israel Hospitals in New York. His manifold activities in the fields of hobby magic and mnemonics have been previously reported. One new item—he has established the Young Collection of American Secular Music at the University of Illinois in Urbana.—**Gordon K. Lister,** Secretary, 294-B Heritage Village, Southbury, CT 06488

31

Addis Kocher writes, "I have been happily married to a lovely Korean woman since December 7, 1986. My first wife, whom I met while a student at MIT, died in 1985, after 51 years of marriage. I have about 10 aircraft in the Smithsonian that I developed and personally installed experimental equipment for. Included are Amelia Earhart's red Lockheed Vega, and I designed and installed the altitude pressure systems for Wiley Post's *Winnie Mae.* I built the autopilots for the B-58 Hustler Bomber and the first 20 autopilots for the DC-10. I received recognition for the DC-10 from Jack Brizendine, chief engineer, Douglas. I also had charge of building the "Loki" missile, first in the U.S. Now I'm lecturing in Morris County, N.J., on 23 different subjects. Slides given to me by the Smithsonian and an excellent series loaned to me by Harold Edgerton, '27, are popular. I have also been a beekeeper for 41 years. I lectured last year at Rutgers State University. Last April I lectured to the graduate students of business administra-

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tion at the University of Korea in Seoul. I was asked if Japanese education is better than American. I said ours is definitely better than Japanese except that they have two parents pushing the students hard."

Leon Kolker writes, "I have been retired since 1961 and have done chemical engineering consulting work for the United Nations in various countries." . . . **John Hollywood** writes, "Amateur radio W1SK. Music, play piano poorly. Used to ski, day hike, but unable to do any more." . . . **Robert Martin** says, "World travel since retirement (1968), 128 different countries, 500,000 miles (more or less)."

We regret to report the following class deaths: **Franklin H. Dewey, Joe L. Franklin, Harry Kamy, and Howard F. Jenkins.** Our deepest sympathy to their families.—**Edwin S. Worden,** Secretary, Box 1241, Mt. Dora, FL 32757; **John Swanton,** Assistant Secretary, 27 George St., Newton, MA 02158

32

What does **Arthur Lacapria** do? Big game hunting, wildlife photography, and horseback riding. He also gives slide lectures. . . . **Robert Teele Billings** is very busy with his intensively cultivated vegetable garden. He also swims and hikes in Vermont and is very active as a volunteer for his church, the Presbyterian Church of the Covenant. . . . **Milton Sisson Hathaway** lives in Midland, Tex., not in Lubbock, Tex., where the recent MIT directory lists him.

Lawrence C. Littlefield and his wife have been retired for about 13 years. However, they keep busy taking care of their 12-room home and ample grounds, which include two in-law apartments. They travel to see their children and friends in California, Oklahoma, Florida, Kentucky, and New England. Lawrence likes to write letters to the editors and to government officials suggesting how to improve and better society. He telephones his children and grandchildren so that he can give them a "continuing education." He believes in affirmative action and moderation in all phases of life. On August 30, 1986, he and his wife celebrated their golden wedding anniversary.

Guy Carl Lentini is interested in music, finance, and investments. His wife, Rose, is interested in Spanish and music. His son, Peter, has hobbies that include the American Civil War, photography, and economics. His grandson, David, is working on his doctorate in chemistry at Harvard University. . . . **Stewart A. Phillips** writes that after living on the shores of Narragansett Bay, he has purchased a small retirement house in the city so that he can be nearer to his activities. These include Hamilton House and church, where he has been a lay reader for 30 years.

Perhaps this is a good time to review who of our classmates have accepted some responsibilities and what their duties are. **Ed McLaughlin** is our class agent. He keeps track of our yearly contributions to our Alumni Fund. He writes a note of thanks to each donor. **Wendell Bearce,** our class vice-president, said he would accept the position of 60th reunion gift chairman. (Wow! The 60th reunion is creeping up fast.) In due time we will hear from him about our class objective and what our options are. Our class estate secretary, **Gaylord Gaynor Langsdorf,** died last year, and the Institute has not yet appointed a replacement. The duties are to help our classmates who are in a position to make a gift to the Institute from their estate to do so in the best possible manner. **Thomas Weston** is in charge of our mini-reunion early in 1989. **John Brown,** president; **William Pearce,** treasurer; and I as secretary take care of the routine matters concerning the class.

We have received the sad news that **Edmund Fritz** died on August 12, 1988, at his home. He was a sales executive for Azoplate Co. until 1968 when he retired and became a business consultant. He attended our 55th reunion with a very attentive attendant, Ms. Anne Thoms. She requested that her name be added to the Friends of the Class of '32. She hopes to participate in class activities in the memory of Edmund.

We have received notice that **Richard Huessener** died September 30, 1988, and that **Gardner Cox** died January 14, 1988. When we receive more obituary information we will pass it on.—**Melvin Castleman,** Secretary, 163 Beach Bluff, Swampscott, MA 01907

33

Happy news! **Paul J. Petitmermet,** married Mrs. Beverly Thompson, September 24 and can now be addressed at 1718 Caminito Ardiente, La Jolla, CA 92037. . . . Another note from **Walt Skees** suggesting combination reunions, in our case classes '30-'35 inclusive.

Obituaries. **John J. Hanlon** died February 18, 1988. . . . **Richard T. Chase** died September 9, 1988 He is survived by his wife at 902 Main Street, West Newbury, Mass. . . . **F. Lawton Barrows** died May 14, 1988. Mrs. Barrows may be reached at 46 South Main St., Middleboro, MA 02346. You understand these notices are printed in the issue immediately following receipt of same. Delays are invariably caused by survivors requiring some time to notify Cambridge.

Jack Frost Andrews is alive and well at 11 Hendrickson Rd., Lawrenceville, NJ 08648. His wife Jermain, a physiotherapist until marriage, followed childraising by teaching at Miss Mason's School in Princeton, hence Princeton Day School. Both play tennis and garden. Jack also volunteers at a wildflower reserve near New Hope. . . . **Julio Ceasar Ulloa,** 600 Grape Tree Dr., Apt. 6A, South Key Biscayne, FL 33149, left Cuba with family in 1960. Prior to that he was president, Sugar Cane Growers Association, executive and director of agricultural credit operation of several commercial activities in Cuba, as well as operating cattle ranches. He has been advisor frequently to governmental technical missions and to international conferences on sugar beets.

Werner Otto Bachli, 9 Old Barn Rd., Lenox MA 01240, apparently spent his entire career with GE, including in Brazil where he married a lady of Alsatian background; his were Swiss. He has done lots of scouting, has been involved with Red Cross First Aid, swimming, lifesaving, alpine climbing, and a member of all outdoor activities within reach; as well as choral singing, and gardening. . . . **Frank J. Bleil,** 1400 Beverly Dr., Visalia, Calif., spent his entire career with CBS, managing shortwave Voice of America Transmission. . . . **Charles Britton,** 9 Vane St., Wellesley, MA 02181, made his career building and operating an insurance agency in the Hartford area. Now he has been happily retired for 10 years in Wellesley.

Robert F. Crane split his life into thirds—first as manufacturing representative in building specialties; then as general contractor in the Boston area, and last as an architectural collaborator in Cambridge. He continues in the west coast of Florida and lives at 212 Margaret Dr., Nokomis, FL 34275.

Ernesto De Sola, Casilia Postal 128, Guatemala City, Guatemala, remembers Dr. Compton, the students, and the excellent faculty. He is thankful. . . . **Roland D. Glenn,** 53 Goodwives River Rd., Darien, CT 06820, worked for Union Carbide in South Charleston 1933-1956, and then in New York from 1956-1968. He retired as vice president of chemical plastics. He is now consultant, executive secretary of ACCH plus chemical engineering.—**William B. Klee,** Secretary, P.O. Box 7725, Hilton Head Island, SC 29938

34 55th Reunion

Let me begin with the confession of a procrastinator: In the last issue I mentioned "unfamiliar"

material from the Alumni Office. Since then I got around to the request for updates to the new Register. And is my face red; there was my copy of the form I was wondering about! Ah well. So let's pick up some more of them.

John Newbegin gave a fairly extensive resume of his career, going back to his time at Tech when he worked five nights and every other weekend on a switchboard to help pay his way. (He was able to arrange a schedule that allowed him crew and some skiing.)

His working career was primarily in mechanical fields: refrigeration and pumps, textile machinery, bookbinding and mechanical and hydraulic presses, and automated conveyors, storage and retrieval systems—to hit the major areas. All along he retained his interest in skiing and for 25 years he was active in the Boy Scouts. He and his wife Helen have two sons both engineers, and a daughter doing part-time work in college as a computer programmer. John and Helen were at the recent mini-reunion at Basin Harbor; with both in good shape.

Stephen R. Phelan seems to have spent a working career in geology and electrical geophysics; in the areas of mining, precious metals, and petroleum exploration. But from what he wrote, along with these went a lifelong interest and activity in the preservation of great Tennessee historical homes, especially his own that dates back to 1828. He notes he has "kept research alive in both earth and economic technologies and in unique history and architecture."

From **Charles Wesley**'s remarks I find that he has a kindred interest and activity in boating education. He is educational officer in Milford, (Conn.), Squadron of the U.S. Power Squadron and served as commander in 1985 and 1986. He has written for several years for the *Connecticut Elder* and was on the board of the Bethany Conservation Trust. The one disappointment he mentioned was that in school he had been turned down for the 150 lb. crew because of a mistaken medical diagnosis. He says, "I am still a strong oarsman and excessively healthy." That's great, but I wonder how many of us can still make weights like that?

Warren Kunz has sent us notes before about Chesapeake Bay living but says again, "Retirement in Southern Chesapeake is the greatest. Great sailing, great gardening and not too darned far to drive to see four children and eight grandchildren, all of whom are in New England and New York."

Finally, for this issue, some words from **Theodore Kresser.** "I have done a lot of writing, but very low tech. My most successful venture was a small book on polyethylene which turned out to be the primer on the subject for a lot of people in the industry. I am a member (50 years) of the American Chemical Society and get to occasional meetings, and the Society of Plastic Engineers—I'm on the board of the local section. Currently I have four grandchildren and two great grandchildren." I've had the chance to get to know Ted and his wife Rosemarie through their attendance at the last two mini-reunions. Considering that their home is in Orange, Texas, that's pretty good. Maybe we're just the beneficiaries of an escape from Texas in the summer but it has become a very pleasant acquaintanceship.

The seemingly inevitable loss this month is **Carleton Davis** of Monroe, Wis. He died August 1, 1988, but beyond that I have no information.

I have two of the regular Alumni Fund notes this time. **Harrison Carlson** writes, "Retired from DuPont in 1969. Moved from my house in Newark, Del., this summer (1988) to a cottage in the Fairhaven Retirement Home in Sykesville, Md. Arthritis in both knees should be less of a problem here."

More about medical problems when **Herbert Andrews** notes, "Broke my hip in July 1987. Hip replacement of titanium metal works fine except I am not allowed to run for any length of time. Otherwise, I am in good health."

As I mentioned in the last issue, by now you should have gotten word of our 55th reunion coming this year. They're lots of fun—try to include us "in".—**Robert M. Franklin,** Secretary, P.O. Box 1147 (620 Satucket Rd.), Brewster, MA 02631; **George G. Bull,** Assistant Secretary, 4601 N. Park Ave., Chevy Chase, MD 20815

35

As promised, these notes are being written in the San Diego area; see my new address, my phone number is (619) 432-6446. I arrived here on October 24 after a 3,653-mile trip with the help of a co-driver as far as Phoenix; spent a day riding the Durango-Silverton Narrow Gauge Railroad in southwestern Colorado and another day taking in the Grand Canyon which I had seen many times before from 35,000 ft. Edie and **Ham Dow** have been a tremendous help in finding an apartment and getting settled. The weather: 70's, low 80's with clear sunny days; great for golf, and living. Here is **Francis Muldowney**'s new address: 7912 Sail Boat Blvd., Bldg. 6 #101, South Pasadena, FL 33707, (813) 360-2581.

William T. Barker and Mae have been happily married 51 years and live in South Lake Holden, Fla. Both are active in church activities. Bill is an eight year member of B.P.O.E. Lodge in Orlando. They both play a little golf. (I remember Mae getting a hole-in-one at Nashua once.) Mae is an active homemaker and beautifier, member of director's (zoning) of South Lake Holden Homeowners Assn., and Street Captain of 15 Home St. . . . **Melville T. Farquhar,** Richmond, Va., has two hobbies: antique clock restoration, mostly tall case clocks; and genealogy. . . . **John C. Tebbetts,** Wellesley, Mass., has three grandchildren.

Louis W. Pflanz, Sierra Vista, Ariz., authored two Signal Corps (U.S. Army) Technical Publications: *Wire Technology,* and *Wire Telegraphy;* and coauthored nuclear weapons employment manuals for U.S. Army Command and General Staff College. . . . **Robert A. Olsen,** State College, Pa., works with Habitat For Humanity. They build houses and sell them at no profit and no interest to people who could not otherwise afford a decent place to live. "We take no taxpayer money. We are now in 250 U.S. cities and 20 overseas countries. Our completely unrealistic goal is to eliminate poverty housing. About 1,000 new families each year escape poverty in this way. My Course XV work pointed me in this direction to some extent."

George C. Morrissette, Louisville, Ky., has two sons, both of whom served in the U.S. Navy; one grandson, three granddaughters and one great-grandson. John, the older son lives in St. Louis, Mo., and works with computers. The younger son, Charles, designs, sells, and installs special machinery in western Europe, Canada, the United States, and Australia. George asks, "Why was the name of Course XIII changed to Ocean Engineering? Much of my work was on the Great Lakes and rivers." . . . **Samuel P. Brown** writes from Punta Gorda, Fla., that another little MIT reunion is planned next April 5 or 6, this time at Panama City Beach, Fla. Speaking to **Lester Moffatt,** who is doing the organizing work this time, he tells me that he has affirmative acceptances from Lee and **Bob Lindenmeyr,** Louise and **J. Austin Cross,** Stella and **Arthur Gilbart,** and the **Browns** and the **Moffatts;** Mary and Jim Eder, and Bob Moody, both '34, are possibles, as are Alice and Winthrop Johns, '37.

I am sorry to report the death of **Gerald M. Golden,** Chestnut Hill, Mass., on October 1, 1988. **John Taplin** very kindly sent me the notice from the *Boston Globe* which I had completely missed. He is survived by his wife Renee, two sons, three daughters and three grandchildren. Gerry was very active in all our class activities and we shall miss him. I am extending our sympathy to his widow and children.—**Allan Q. Mowatt,** Secretary, 715 N. Broadway, Apt. 257, Escondido, CA 92025

36

Still catching up on other news, after taking four issues to recount our wanderings and visits eastward. President **Alice Kimball** reported that class representation at Alumni Day 1988 included **Larry Peterson** and Lillian, **Leo Kramer, Bill Metten** and **Jack Zietlow.** Shortly thereafter in June, Alice was chosen by her fellow townspeople to moderate Hartland's town meeting. Judy Woodruff and Jim Lehrer move over! **Harry Essley** and Betsy reponded to my thanks for their hospitality in Rochester with news of a week in July when all their four children and assorted spouses and grandchildren were together for swimming, sailing and canoeing at their Conesus Lake cottage.

A note of thanks from **Jack Stapler**'s widow Dorothy for our tribute (July '88 Notes) mentioned hearing also from **Russ Miller.** At the end of junior year Russ and Jack worked their way across the Atlantic as deck boys on the American Scantic Line for $15 per month each, plus meals. They were both seasick, so the Line certainly got help "on the cheap." Jack wrote a book about his coastwise shipping endeavor from Boston to Maine in the late 1930s with **John Myers** and **Alden Anderson.**

A clipping from the *Redwood City* (Calif.) *Tribune* dated August 2, 1988, tells of John's devising a water usage chart to help townspeople avoid fines of up to $200. Water was so scarce that the city required a 60 percent reduction from usage over the previous twelve months, with a fine of four dollars per 40 gallons excess.

On a trip from Santa Fe to Boulder, Colo., to give one of my grandsons a look at University of Colorado, I stopped in Wheat Ridge to visit **Bob King** (Course XII) and Oleta. Bob told of his winning the Cabot Medal as an undergraduate for the best physical improvement, and he added that, if you saw him at the award, "you would wonder what shape I was in to start with." He recalled **Aurelius Horner** in the geology course, and regretted that their paths did not cross again. "Re" was in the East with Reynolds Metals, and Bob went with Climax Molybdenum in Colorado—until 1948, that is, because 11,500 ft. thin air at his Fremont Pass post thickens some bloods, and he had to relieve the condition periodically by descending to Denver, and being tapped frequently by the blood bank. So he left Climax and continued his career with the U.S. Geological Survey in Denver. His explorations for scarce and critical minerals took him all over the country, and to Mexico, Brazil and Canada. Bob and Oleta's home is a museum of art: her exquisite needlepoints and pettipoints, his mother's expert pastel paintings, his daughter's painting and leaded stained glass creations, and Bob's restorations of fine old frames to enhance them all.

When I called **Ed Rowe** to thank him for the news clip on **Warren Sherburne**'s death (November Notes), wife Anne answered that "Ed has just gone down to the boat." So I was surprised to learn from a follow-up note that he is legally blind, or more so. He had dictated the note to Anne because reading and writing are next to impossible. But isn't it heartening that he uses his peripheral visition to sail a Morgan 24 on Long Island Sound and Connecticut rivers? "In September it can be great," he said. Ed was with Newport News Shipbuilding for 16 years, then in 1952 moved to Electric Boat, where as planning engineer he was in on the start of the *Nautilus.* He retired in 1979 as chief of cost estimating. Anne reads class notes and the Course XIII notes to him, so he keeps in touch.

Correction on last issue's Notes: **Dave Varner** is not fully active, but "only about four hours every business day," and he is up around 5 a.m. to beat the awful traffic from the suburbs into Washington, D.C. He does some gardening, more golf, and he and wife Mary travel here and in Europe regularly. They were in Albuquerque and Santa Fe over Labor Day weekend, but we were una-

ware of each other's presence. Please, everyone, make a note of my address and telephone number when you come west of the Pecos. I want to hear from you and visit with you.

Jack Ayer's substantial contribution to the Campaign For The Future is made to a scholarship fund which he established in memory of **John Easton** in 1979, and which Jack supports annually. You will recall that John died in an airplane crash returning from a business trip, shortly before he was to retire. They were close friends, and Jack was meeting him at the airport. Jack retired in 1974 as vice-president of operations of Denver & Rio Grande R.R., but he is still trying to catch up in Denver on the many domestic jobs put aside during a busy career, and in Maine at his family's home which he tries to visit each summer.

Let's raise our glasses in toasts to honor the lives of **T. Philip Norton,** who died September 5 last year; and **Benjamin Lippold** who died June 20. Phil was Captain of varsity boxing in 1936, and kept fit with golf. His 30 years in engineering with American Cyanamid made him well known among his counterparts around the country. He suffered a stroke three years ago and lost his speech just before our 50th reunion, which he had looked forward to attending. Wife Nan says he enjoyed life fully to that time. She continues at 4 Spring Dr., Bel Air, MD 21014. News of Ben Lippold's death came from a note on an otherwise blank questionnaire—"Deceased 6-20-88," and no signature. The telephone is disconnected at his Fresno, Calif., address where he practiced architecture for many years. If any of his fellow DEKES or Course IV buddies can fill me in, please do.

I have received a sheaf of your notes responding to the questionnaire, for which please accept my sincere thanks. They will be reported in these Notes beginning next issue.—**Frank L. Phillips,** Secretary, 901 Los Lovatos, Santa Fe, NM 97501, (505) 988-2745; **James F. Patterson,** Assistant Secretary, 170 Broadway, Pleasantville, NY 10570

37

James Marvin Ewell, 9000 Indian Ridge Rd., Cincinnati, OH 45243, is a member of the Board of the Cincinnati Childrens Hospital (past president and chairman), on the Board of the Cincinnati Symphony Orchestra (past president and chairman), and Board president of the Cincinnati Nature Center.

Edward M. Fischer, 19 Holly Dr., Olathe, KS 66062, writes, "My dear wife, Emily Blessing Fischer, graduate of Colorado University, entered the Delmar Gardens Nursing Home on October 2, 1987, with Alzheimer's disease. I took early retirement in 1974 to see the world and enjoy life. Unfortunately, our plans were curtailed in 1978 when Emily suffered two severe strokes. I had a very pleasant surprise a few weeks ago when **Harry Metz,** Course III, called from Phoenix, Ariz. He was retired from Phelps Dodge and lives in Bisbee, Ariz. First time we talked to one another in 50 years. We were classmates and roomates."

Earl Donald Fraser, 2237 Ehrborn Way, Sacramento, CA 95825, writes, "I go pheasant hunting with my Brittany Spaniel. Skied until I had a stroke. Play bridge. Learning to cook a little." . . . **Robert Clifford Glancy,** 41 Grandview Ave., White Plains, NY 10605, writes, "We had our 50th wedding anniversary on Easter Sunday and then learned of the tragic death in an automobile accident of our 16-year-old granddaughter two days later. Our eldest daughter Carol is a colonel in the USAF and is now stationed at Offut AFB in charge of the air force's new Wellness program."

Ellsworth Putnam Head, 5030 High Point Rd., NE, Atlanta, GA 30342, writes, "I was only able to attend MIT for one semester due to financial difficulties. As a result I was never able to get my degree in sanitary engineering. Even though I was in the class of 1937, I never was able to get well acquainted with other class members. I am proud to have been able to attend MIT."

Fred David Kierstead, 312 Moon Ave., Brandon, FL 33511, writes, "I am actively involved with amateur radio, teach licensing classes twice annually, and am chief volunteer examiner for Brandon Amateur Radio Society. My number two son, a professor at University of Houston, Clear Lake, Texas, has been awarded a Fulbright Scholarship and expects to spend six weeks this summer in Egypt, followed by a brief visit to Israel." . . . **Willard Marcy,** 142 Lincoln Ave., Ste. 781, Santa Fe, NM 87501, writes, "after having lived on the East Coast for almost 70 years, my wife Helen (for 50 years this year) and I have moved to the Southwest semi-arid mountains of Santa Fe, New Mexico, where we are adjusting to high altitude and a new (to us) three-sided culture, vastly different from the East Coast environment."

As some of you may know, **Edwin Harrison Olmstead**'s wife Ruth, (326 Pine Rd., Mt. Holly Springs, PA 17065) has been ill for six years. With some urging he has authorized inclusion of this story because it may be of help to someone else who is unfortunate enough to have a similar experience. He writes, "Six years ago my wife of 40 years, without warning, was struck down by congestive heart failure. Within a month, open heart surgery replaced her mitral valve with one of stainless steel. Initial recovery was spectacular. Then barely perceptible decline, apathy, depression, bizarre behavior, incoherence, brooding, and delusions took over. Between May 1985 and February 1987 psychiatrists in five local hospitals reached the unhelpful conclusion 'this is not the right facility for her.' Five institutions of national renown refused, perhaps for excellent reasons, even to consider her case. During this crisis Classmate Bob Ferguson solicited an appropriate gift for our 50th reunion of May 1987. Hearing her problem, he volunteered help: Sewickley Valley Hospital prides itself for refusing no one. After three years of decline, within seven days there her psychiatrist—by then her 10th—generated the *very first* organic diagnosis: multi-infarct dementia, perhaps resulting from open heart surgery. His prognosis was gloomy and hopeless. Fourteen months since, however, in the nursing home nearest to his office, she shows many signs of slow improvement in body and spirit. It will never become possible adequately to thank or repay Bob, after 50 years in our own separate orbits, for materializing in the right place at precisely the right instant. I am driven by hope that in some way her misery, sacrifice, and tragedy may contribute to quicker diagnoses and greater well being for others. After doing everything possible for her comfort I seek to place her case history into some data base(s) relating her scourge statistically and constructively to its probability as the result of open heart surgery, metal implants, warfarin, other medication, singly or in combination. Difficulty facing her prospects is in small measure relieved by indulging my lifelong love affair with technology. Some escape comes from research and writing about the most engaging subject I can find: technical aspects of American Civil War ordnance. Intense concentration gives perspective for other difficult problems without apparent solutions. Less captivating activity promises inattention, boredom, and lethal brooding."

Leonard Arthur Seder, 19 Seaborn Pl., Lexington, MA 02173, conducted seminars in quality control for 20 years in Europe and the Middle East. He conducted over 200 seminars and/or conferences and local presentations over 30 years. He is still actively engaged in consulting as quality control engineer.—**Lester M. Klashman,** Secretary, 289 Elm St., Apt. 71, Medford, MA 02155

38

We sat with Marie and **Paul O'Connell** on September 25, at the "Cardinal and Gray" luncheon at McCormick Hall. From them we learned of the sudden death in August of Janet Cooper, widow of our classmate **Ross Cooper,** who died the same month four years before and just a couple of months after attending our mini-reunion at Endicott House.

Incidentally, the Cardinal and Gray group includes any alumni (and spouses) whose MIT class graduated 50 or more years ago. So let's have a better show of classmates next time. It's one organization where we are now the most junior in age, and one of the few occasions where we can sport our new red blazers.

From **Al Wilson** a copy of the United Way Massachusetts Bay publication that includes kudos for **Norm Leventhal** and his Beacon Companies. Serving its seventh year as a United Way Pacesetter, the firm held an outing last year at one of its residential sites for the handicapped and elderly. Last year's company participation in United Way: 99 percent.

Our November/December notes reported that under Norm's leadership The Friends of Post Office Square would soon begin work on replacing the eyesore parking garage there with a one-and-a-half-acre downtown park over a new 1,400-space underground garage. The October 6 *Boston Globe* reported 120 city officials and business people had gathered for a celebration, complete with band, on the top of the old garage to mark the actual start of its demolition. More in 1991, when the new park will be dedicated.

Two items from **Lou Bruneau.** He went back to school for a week in September at UMass/Amherst to take a course in assessing. The town of Chatham, Mass., is fortunate to have Lou on its board of assessors, in view of his lifetime career as a CPA. . . . Lou also reported that Millie and **Ed True** had just returned from a five-week tour in Europe, starting in Copenhagen and ending in Rome.

During an Alumni Fund telethon I talked with **David Morse, James Pollock,** and **Edgar Taft.** Dave's current activity as a member of the American Arbitration Association involves a complicated case on the Cape. (Hope it doesn't involve other '38ers.)

Jim transferred to MIT from Dartmouth. Having been active in Little League, he was watching the final game of the World Series when I interrupted him. After graduating from MIT with an S.B. and S.M. in geology, his mining and exploration ventures took him to many countries around the world. As a geologist registered in California, he has reciprocal licensing in Arizona, where in retirement he still engages in consulting.

Edgar was a pathologist for 33 years at Mass. General Hospital, was on the faculty of Harvard Medical School, and was research administrator at MGH from 1966 to his 1983 retirement. Currently living in Stockbridge, Mass., he is president of the board of directors of the Pittsfield Community Music School. Winters are spent in Puerto Rico; summers in western Mass., where besides gardening he is especially active in the Appalachian Mountain Club, serving on the local committees that maintain 65 miles of hiking along the Appalachian Trail, which runs 2,500 miles from Mt. Katahdin in Maine to its southern terminus in Georgia.—**Donald P. Severance,** Secretary, 39 Hampshire Rd., Wellesley, MA 02181

39 50th Reunion

Ninety-three classmates indicate they expect to attend our 50th reunion starting June 4, 1989, at Chatham Bars Inn, Mass. The reunion committee, co-chaired by **Doc Wingard** and **George Beesley,** met during September in Cambridge. Attending were **Eleanor Beesley, Bill Brewster, Dodie Casselman, Joe Dana,** Ginny and **Fred Grant,** Connie and **Manning Morrill, Bob Pratt,** Anne and **Fred Schaller,** Sylvia and **Seymour Sheinkopf, Sid Silber, Paul Stanton, Os Stewart, Aaron White,** and members of MIT staff.

By this reading, each '39er should have

received registration forms on which he can order a blazer, hotel reservations, class photo, theater tickets, Pops tickets, meal tickets, and make his other choices for activities at the Cape and on campus. One hundred rooms are reserved, and room assignments will be made in the order that commitment checks are received at Chatham Bars Inn.

The reunion gift committee, chaired by **Jim Barton,** met next day. Attending were Mary Barton, Marie and **Pete Bernays, Bill Brewster, Dodi Casselman,** Ginny and **Fred Grant,** Jean and **Mike Herasimchuk,** Lucy and **John Herlihy, Harold Hindman, Jim Laubach,** Louise and **Charles Mercer,** Connie and **Manning Morill,** Margery and **George Morrison, Bill Murphy,** Berta and **Larry Perkins,** Anne and **Fred Schaller, Paul Stanton, Os Stewart, Ted Wroblewski** and members of the MIT staff. Each committee member reported and, based on the trend-to-date, the bottom-line total of gifts, pledges, and percent of class contributing may set a new Institute record!

Fred Grant, Fred Schaller, and **Ernie Kaswell** expect to produce a miracle, which is to deliver to each subscribing classmate his 50th reunion class book, including pictures and biographical notes, within three months after the editors' input deadline.

Mention of a miracle reminds me of two major miracles which affected our class. First, 120 years ago on Boylston Street, a group of people had the foresight and courage to start MIT, and, second, during the following 120 years, a steadily-growing number of others confirmed the necessity and value of the idea, and they supported it by teaching on its staff and contributing in cash and in kind. Now we '39ers have an ideal opportunity to contemplate these miracles from a 50-year perspective and, at the right time for each individual, express our thanks.

After the Cambridge meetings, Mary and **Jim Barton** visited Trixie and **Gordon Pope** in Ossipee, N.H., and returned to the Northwest where they were surprised to see, strung across the road at Hunts Point, a banner reading, "Celebrate Jim Barton, Sunday, October 16, Town Hall." (Jim had just retired from serving his community for 9 years as councilman and about 21 years as mayor.) At the Sunday reception, there were speeches of appreciation and presentation to Jim of a new portable battery-operated three-wheel vehicle for touring his grounds and calling on his neighbors.

Eleanor and **George Beesley** sold their business and, in retirement, traveled to China and Alaska. On a recent trip they visited Lynn and **Nick Carr** in Newbern, N.C., Prilla and **Gus Hunicke** in Westbrook, Conn., and Anita Wingard in Baltimore.

George Cremer circled the U.S.A. again. He and **Bob Youngquist** visited the Silver Hill Annex of the Smithsonian Institute, where George was surprised (and delighted) to see (on an SST) an afterburner thrust-reverser he helped develop during his career with Solar Aircraft Co. At Hingham, Mass., George visited **Stu Arnold,** who had just returned from winterizing his house on the Cape.

During his final years, **Richard Feynman** prepared a manuscript, which has just been published, titled *What Do You Care What Other People Think?.* The book is wise, reminiscent, and serious, as it deals with people who influenced him and with some wonders that abounded in his life.

Pete Bernays relayed news of the death on September 9, 1988, of **Irwin K. Weiss,** Course II. There were no details.

Art Curtis sent clippings from the *Hartford Courant* newspaper reporting the death, on October 19, of **Wesley A. Kuhrt.** Wes was former president of Sikorsky Aircraft and after 43 years with United Technologies Corp., retired as senior vice-president. In 1984, the UTC board of directors and senior management honored him by naming a new optics facility in West Palm Beach, Fla., "The Wesley A. Kuhrt Optics and Applied Technology Laboratory."—**Hal Seykota,** Secretary, 1701 Weatherswood Dr., NW, Gig Harbor, WA 98335

40

A recent note from **E.P. "Digi" DiGiannantonio** reviewed his activities since he retired from the U.S. Navy. From 1954 through 1956 he worked at Dr. Draper's Instrumentation Laboratory. Then he went to Raytheon, to Bunker-Ramo, TRW, back to Raytheon, and then Edo Corp. He retired from Raytheon, and recently from Edo Corp. He has just joined Metropolitan Home, Realtors, in Vienna, Va., as director of the Land/Commercial Division. This is a new field for Digi, but investment opportunities are abundant, with profit potentials extremely lucrative, and a tremendous challenge. He points out that the greater Washington, D.C./Northern Virginia area is a very dynamic and explosive region. He would be very happy to hear from any classmates at his office, (703) 893-3300 or at home, (703) 437-7644 in Reston, Va.

A notice in the American Chemical Society News notes that the Ernest Guenther Award in the Chemistry of Essential Oils and Related Products sponsored by Fritzsche Dodge & Olcott Inc., was given to **Henry Rapoport,** University of California, Berkeley.

It is necessary to report the death of **Reeve C. Morehouse** of 54 Marina Blvd., San Rafael, Calif. There is no further information, except that he passed away August 4, 1988. . . . Also, we must note the passing of **Alfred E. Castle** on July 9, 1988. He lived at 131 Kent Ave., #E, Kentfield, Calif. A news item reported that Alfred was a major in the U.S. Army Air Corps during World War II. Thereafter, he spent 30 years with Eastman Kodak Co., and then worked as a self employed accountant and tax preparer. He also collaborated on five books. The class extends its sympathy to both families.

Keep those notes and calls coming.—**Richard E. Gladstone,** Secretary, 1208 Greendale Ave., Needham, MA 02192, (617) 449-2421

41

Barbara Livingston wrote the *Technology Review* that **John Adolph Livingston** died on Labor Day during a cardiac procedure. John was 72 on September 3, 1988. As a student he was active in many musical activities: assistant concert master, member of the Glee Club and the Combined Musical Clubs. He studied naval architecture and marine engineering.

Malcolm J. Abzug writes: "I retired from aircraft stability and control engineering this year. Most recently I worked on the Northrop B-2 and on a unmanned aerial vehicle (UAV) for a small local company. I missed the 45th reunion, but my wife, Gordon, and I got to Cambridge for the 50th anniversary of the Wright Brothers Wind Tunnel, where I did grunt work as an undergraduate. I keep in touch with my classmates: **Charlie Butt, Chet Hasert, Bill Lamar,** and **Bob Wallace Blake.** In retirement I find that engineering skills are appreciated by local environmental and community groups."

Malcolm enclosed a resume that he put together for a local newspaper from which we quote: "Dr. Abzug served as adjunct professor of aerospace engineering at the University of Southern California, Los Angeles. He was a naval lieutenant in the Bureau of Aeronautics during World War II. He worked for Douglas Aircraft for 16 years; during that period he received the Douglas Engineering Achievement Award, for contributions to aircraft dynamics. He worked later at the Sperry Gyroscope Co. and at TRW Systems. At TRW he was manager of the Controls Design and Analysis Department. Malcolm is the author of over 100 reports and papers. In 1974 he was elected fellow of the AIAA. It is not surprising that Malcolm is licensed for single and multi-engined planes and for instrument flying. He holds the International FIA Silver Badge Soaring Award. Malcolm is married to Mary Gordon Breeden. They live in Pacific Palisades, Calif., have two grown sons and four grandchildren. He is active as a director of the Pacific Palisades Residents Association and of No Oil Inc. He and his wife like to hike locally with the Sierra Club and the Topanga Canyon Association." They are planning to attend the 50th reunion and your secretary hopes to find out what Malcolm's nickname is.—**Joseph E. Dietzgen,** Secretary, Box 790, Cotuit, MA 02635

42

We have a letter from Professor **Jack Flipse,** who has the following impressive titles: associate deputy chancellor, associate dean of engineering, and the deputy director of the engineering research center! Jack is in the midst of establishing a new offshore technology center for Texas A&M and the University of Texas, funded for a cool $28 million over the next five years. Maybe we ought get him to do some alumni fund raising for the class?

Al Hayes, our indomitable class archivist (bet that we're the only class with an archivist), tells us that he's still getting responses to the class questionnaire. If you've not returned yours to Al, please *do it now.* You don't want to be unrepresented in his records. The address: Dr. **Albert E. Hayes, Jr.,** P.O. Box 730, Yucca Valley, CA 92286. If you've mislaid the form, write to Al and he'll send a copy to you.

Jean and I will be at: 2222 Americus Blvd. N., Clearwater, FL 34623, from November 21 until April 30. Send class news there. And do visit if you're in the neighborhood. Otherwise, all is quiet on this front, not even an obit, for which we give thanks.—**Ken Rosett,** Secretary 191 Albemarle Rd., White Plains, NY 10605

43

I must first sadly report the deaths of four classmates. For reasons unknown, we have just now learned about the passing, in 1975 of **Frank X. Grossi,** in Chesterfield, Mo. . . . In September and October, 1988, we lost **George Floyd** of Victorville, Calif.; **J. Barrie MacKenzie** of Manchester Center, Vt.; and **Warren Fuchs** of Syosset, N.Y. We will miss these fellows, and extend our condolences to their families.

Stewart Rowe writes from Cincinnati that he is enjoying his retirement from P&G since 1987. Freed from daily workaholic pressures, he now helps poor and elderly persons with their tax returns, and in a very relaxed way deals with home maintenance, sports and civic activities. He recalls undergraduate journalistic adventures with *The Tech* and *Vu,* and wonders what has become of Joe Tankoos. (Joe isn't listed in our class printout, so he's either in the next world or in another class.)

From Bangkok, Air Chief Marshal **Siddhi Savetsila** writes that he has been Foreign Minister of Thailand for eight years and three months (a record?). He is presently chairman of the standing committee of ASEAN.

Marshall Waller, '46, whose hobby is salvaging scrap gold, has obtained an unidentified 1943 Class Ring, in perfect condition, which he is willing to sell for the scrap gold price. Anyone interested may call him at his home in Potomac, Md., (301) 762-9186.

During the MIT chemical engineering centennial celebration in October, class president **Jim McDonough** seized the opportunity to convene a meeting of the 50th reunion provisional committee with **Ken Warden, Chris Matthew** and **Bob Rorschach.** Possible reunion schedules and locations were discussed, and it was tentatively decided to appoint regional members to the committee to provide closer contact with classmates

over the next five years.

As an interim activity, **Harry Ottinger** has proposed an October 1989 meeting of the GSWCFMM (Great South West California Florida Midtown Manhattan) subgroup of the class in Albuquerque. Activities will include eating, drinking, socializing, sightseeing and hot air balloon rides. If interested, write to Harry at 5 Junior Hill Loop, Albuquerque, NM 87122.

A statistical echo from Newport: "The Class of '43 is almost a ton heavier, its butt is an acre broader, and its hairline has receded over a mile and a quarter." Harvard, of course.—**Bob Rorschach,** Secretary, 2544 S. Norfolk, Tulsa, OK 74114

44 45th Reunion

On a hot-air balloon trip to the Loire River Valley in August, one of your co-secretaries was surprised to find that one of his companions in the basket was Cornelius Van S. Roosevelt, '38, who was enjoying his fifth such adventure. We had a great time reminiscing about MIT and decided that we would recommend ballooning to all classmates of both classes. Later in the fall I was fortunate enough to serve on a panel that chose **Edgar P. Eaton, Jr.,** for the Manufacturers Medal of the James H. McGraw Award. These awards were established by the founder of McGraw-Hill, Inc., in 1925 to encourage constructive thinking for the advancement of the electrical industry. Ed's citation reads, "For distinguished leadership and stewardship to the industry and to the community." Ed has had a brilliant career starting with General Dynamics, then to Allis-Chalmers, and then to Carbone Corp., which is now Carbone-Lorraine Industries. He became president of that company in 1971. His engineering skill is exemplified by his seven patents, while those of us who remember his exceptional job as 40th reunion gift chairman are not surprised that part of his nomination for the award reads, "In a career spanning 40 years, Edgar P. Eaton, Jr., has shown the sort of inspiration, leadership, and dedication that typify industry pioneers."

Bob Peck reports that after two heart attacks, a bypass, and lamindectomy, he is now finally healthy. He is handing over his company to his son, Matt, and last fall began a two-year term as president of the MIT Club of Maine. Bob also received a newsy letter from **John Toland,** who reports that he and Dode have two daughters and three grandchildren. He is practicing for retirement in a couple of years. John's company is Summerville Steel—a specialty steel distributor. It has about $6 million in sales, 23 people, and good profitability. He still enjoys skiing and tennis and is trying golf again after quitting in frustration many years ago. John believes that now that he has attained a certain mellowing, he may be able to enjoy it.

It is our sad duty this month to report the deaths of three classmates. . . . **Robert G. Fisher,** Course XV, died in August. We have no details. Our sympathy goes to his widow, Joanne, who is living in Denver, Colo. . . . **George R. Shaw,** who attended Harvard before coming to MIT to receive his degree in architecture with our class, died in September. He was the owner of Contemporary, Inc., and Contract Interior Design of Concord, Mass., and Brookline, N.H., for many years. He served in the U.S. Army during World War II, and during the 1950s he hosted a classical-music program at WCRB in Waltham, Mass. He was also an accomplished pianist. He is survived by his wife, Rita, a daughter, a son, and a granddaughter. . . . **Edward Artim** died in 1985. We have no further details.

By the time you receive these notes, we hope your plans for the 45th reunion will be well formed. We apologize for our sometimes premature notices of mailings. Our enthusiasm carried us away.—Co-secretaries: **Andy Corry,** 16 Brimstone Lane, Sudbury, MA 01776; **Lou Demarkles,** 53 Maugus Hill Rd., Wellesley, MA 02181

45

An early Happy Easter to you all. Yesterday was Election '88, and Thanksgiving and Christmas will have long since come and gone by the time you receive these notes. We have not yet determined its significance, but the Election Day issue of the *Boston Globe* had a 5.5" x 8.5" photo of **Frank Gallagher** aboard a wind board captioned "Gust in Time—As the wind picks up, Frank Gallagher puts his sail board in the water off Castle Island."

I have been reminded by the groom's mother that I am to advise that Karen Hennigan and Jonathan S. Springer were wed in Saratoga Springs, N.Y., on October 15. As are all weddings it was a great affair and the beauty of the bride was only outdone by the charm of the groom's father! Karen and Jon are both attorneys living in Concord, N.H. Fran and I are delighted to have Karen as a daughter. My only fear is conflicting legal advice.

Billie and **Al Bowen** visited with us here in New Castle, N.H., in mid August for our not-so-annual bridge marathon. After seven hours we won by about 1,500 points—the first Springer victory after some 20 tries.

Richard H. Battin, along with 26 other retirees, was honored last spring at Lincoln Labs' Annual Retirement Banquet at the Faculty Club. With 29 years of service to the Lab, Dick has given engineers, scientists, and students the necessary background to understand and contribute to the field of astrodynamics. Dick's other professional endeavors include an MIT course he has given for more than 24 years, plus a book published as the standard for astrophysics.

The January, 1988, issue of the *Wall Street Journal* indicated that **George S. Berman,** chairman at Unitrode Corp. in Lexington, Mass., had given up his CEO title —another retiree! . . . And not to be outdone, **David R. Clare,** president and chairman of the Executive committee at Johnson & Johnson, will be stepping down at the April 26, 1989, annual meeting. Dave will continue as chairman of the Finance Committee pending his retirement at 65 in July 1990. Yes, Dave was (and is) one of our younger classmates—an individual who thrived on long hours and 7-day weeks throughout his career at J & J.

Fran and I recently had lunch in Newburyport, Mass., with Lou and **Pete Hickey,** and Pete reported on his alumni fund raising at Phi Gamma Delta. . . . Pete also reported that **George Brothers** of Mobile, Ala., after almost a lifetime working in the hay and feed business, is back in engineering. . . . Although they had a conversation, Pete could not recall the status of **Ed Reed.** Our last report was that he was a manufacturer's representative in the Houston area. . . . Pete had no luck reaching either **Hank Rudkin** (of Pepperidge Farms bread fame) or **Slim Pasfield** (a retired or almost retired professor of chemistry at St. John's University in New York City). . . . We heard nothing but raves over Jimmie and **Tom Stephenson**'s month in Europe—all first class, QE2, Concorde, etc., etc.

In mid September a welcomed letter from **Ed Stoltz** brought us up to date on his and Elinor's retirement activities—a few months a year in Phoenix, travel that includes one or two Elderhostel tours per year, a trip or so to Europe, golf three or four times a week, plus a little bridge but only on Elinor's part. Although Ed's letter almost wore me out, I must agree that the Stoltzes are enjoying their retirement. Ed also indicated that he and Elinor were keenly interested in the Ireland trip suggested in our October notes, as was **Tony Shubert** of Hutchinson, Ky. Unless we hear from more of you in the interim, this mini-reunion will not come about.

One death to report: **Randall D. Estes, Jr.,** of Hendersonville, N.C., on November 18, 1986. All we know is that Randall, a physics major and retiree, was a Texas resident at the time of our 25th. His only known survivor is son David R. Estes, '68, at APO San Francisco.

How about some news items!—**Clinton H. Springer,** Secretary, P.O. Box 288, New Castle, NH 03854

46

Well, the "lads" are at it again. In early October (should have marked the date) I got called out of bed to answer a phone call from "Fall, Nevada." Thank goodness it wasn't collect because it was **Bill Cahill** with some cockamammie story about being pulled in by the Highway Patrol on a D.W.I. or some such and needed me to fly out right away to post bail. Turned out, **Jim Chabot** was aiding and abetting this scene, so it took a while to sort things out. They had me in stitches; I'll tell you that. It sounded as if they had broken the bank at Harrah's South Tahoe and were celebrating. Too bad I couldn't have recorded the conversation, or at least written it down on the spot.

Meanwhile I'm wending my way down through the bottom of the alphabet in the bio book, dreading the day when I have to start at the top again and do some Creative Writing 201. . . . First I see a couple of double E V-12ers, neither of whose plans include retirement. **Dave Sherrick,** a Bronxville, N.Y. preppy, left the U.S. Navy shortly after graduation and went on to become a R&D managing director with SCM in Chicago, later moving to Bethesda, Md., where he still lives with wife Helen, a registered nurse. Dave stepped up the ladder to vice-president with Rixon, Inc., in government marketing and later, as vice-president with Versitron, Inc. In 1981 he and a partner founded C.R. International Inc.: "Dedicated to serving the secure communications needs of the U.S. Government and its friends." More recently they formed a subsidiary, C.R. Labs, Inc., which does the TEMPEST secure testing which we had to pass when I worked in a "sensitive" program. The Sherricks have three children, mostly grown, including a son who got his master's in double E at Tech with honors, only to change careers, going into medicine—at George Washington University and their hospital for his residency. . . . **Clifton Sibley,** a Wellesley (high school) spinoff, went right into National Research Corp. in Cambridge and stayed with them for 20 some years, including three years in Geneva and several trips to Asia and France, where he set up a vacuum equipment plant in St. Julien. He left NRC in 1968 to go with Norton Co., heading their silicon crystal growing and semiconductor development. He pulled out in 1981 to start his own consulting business, designing vacuum coaters and furnaces. Clifton's wife since 1951, Ann, went back/on to receive her B.A. in English with a summa cum laude and Phi Beta Kappa at Boston College in 1986. The Sibleys live in Needham, Mass., and have four boys and a daughter, all grown.

Chuck Thompson, another V-12 meteor man, did two years in the Atlantic Fleet Weather Center in Norfolk, but he didn't stay with it. After that he went straight into sales, first with Youngstown Sheet & Tube, then with IBM for 37 years, moving around to seven places including Cleveland, Sweden, and finally Atlanta where he and wife Charlotte, of 40 years come June, still live. They have a son and a daughter, both grown up. Chuck retired in 1986. . . . **Jim Todd,** a rare Course XVer (in those days), has worked the field since graduation, starting with Proctor & Gamble in Baltimore then Cincinnati. He went on to Robert Heller in Cleveland until travelling burnout drove him to Union Carbide. Finally he has started his own Management Consulting Services with headquarters (and home) in Westport, Conn. In addition to his profession he has strong attachment and participation in the Episcopal Church where he's applied his consulting skills in parish development. His first marriage bore two boys and a girl, all grown, before his wife died in 1979. Since then he has remarried, to Kathleen

Troy.

Last, and no doubt "least," just for fun, is **Chuck Wellard's** contribution, quoted here in its entirety: "(A) Wife—Jane; Children—Penny, Paula, Charles; (B) Started company plus sold it; (C) Financial promotion." Oh yes, Chuck, who prepped at Mount Hermon (Mass.) School, joined "a few" V-12ers in double E. Anything you'd like to add, Chuck? Seems to me you came in "from the fleet"?

A correction and apology to **Roy Klein** whom I wrote up in the Aug./Sept. issue. A booboo (probably caused by my virus-infected computer) turned Roy's company from *Fluor* to *Flour.* A big fat ooops!—**Jim Ray,** Secretary, 2520 S. Ivanhoe Pl., Denver, CO 80222

47

Irving Schwartz writes to tell us he sold his business in 1981 and "has tried to be a 'do-gooder' ever since." He asks why we were so unlucky as to become class secretary? I guess, Irv, it was a similar urge to be a "do-gooder"!

When Irv wrote in September he was on his way to China to conduct a seminar on total quality control. He had lectured on work simplification two years before at the Wuhan Iron and Steel Co. and they invited him back. The Wuhan Co. has 250,000 employees and one of the finest hot-rolling mills in the world. With 50 million people coming into the labor market each year, China's greatest economic potential comes from its unique human and natural resources. However, what works well for underpopulated developed countries could be disastrous for China. Therefore, Irv is careful to "expose" rather than "recommend" new management concepts.

Notes from various sources. . . . **Norman Greenspan** is president and CEO of Rogers Corp. in Connecticut, which makes specialized materials and components for the electronics industry. Sales in 1987 were $145 million. . . . **Edward David** is a member of the White House Science Council; he's employed by Exxon Research and Engineering Co. . . . **Robert Ballufi,** a professor at MIT, has received the 1987 Acta Metallurgia Gold Medal. This international award recognizes outstanding ability and leadership in materials research.

Sumner Scherer died in August. He taught school in Weston and Wayland, Mass., for 35 years before retiring to Winchester, N.H. He is survived by his wife, Marilyn, four children, and seven grandchildren. Sumner was a classmate of mine in course XV.—**Robert E. McBride,** Secretary, 1070 Pilgrim Pkwy., Elm Grove, WI 53122

48

Frank Jones sent many boxes of potato chips to the 40th reunion hospitality suite. Frank's company makes potato chips with different seasonings. The mexican style are spicy hot, the barbeque style have tomatoes in the recipe, and the dirty style have the potato skins. The company is distributing from Maine to California and they are about to move into a new manufacturing facility in Memphis. Frank owns a Mexican restaurant in Memphis. A family had run the business for many years before Frank purchased it. One change Frank has made is to add a few items to the menu. He finds it fun to have lunch in his restaurant during a busy week in the office of his firm, Summit Asset Management, Inc. Frank also owns Shelby Diecasting in Mississippi. Recently, he entered a joint venture with the Japanese to create a company in Madison, Ind. The company casts machine parts which are shipped to Honda. Frank visits the Indiana plant every week.

Peter Spitz published his first book entitled, *Petrochemicals: The Rise of an Industry.* The research, writing, and editing took over three years of Peter's spare time. The book is described by E.C. Holmer, formerly CEO of Exxon, as follows: "The petrochemical industry erupted from nowhere to become a great industry in only several decades. This is a fascinating story about how it happened." The book has technical depth with useful information on the technology or organic chemicals and polymers which are processed to create moldable plastics, manmade fibers, and numerous thin plastic films. Peter also writes about the business side of the industry. Peter participated in many facets of the petrochemical industry, first at Exxon; then, at Scientific Design Co. (with Ralph Landau), a firm that developed and commercialized a number of chemical processes. In the mid-1960's Peter and another MIT alumnus founded Chem Systems, Inc., a consulting firm specializing in providing services to the chemical and process industries. The firm has grown to 100 professionals, with offices in Europe and Japan. Peter is chairman and director and is active in sales and in directing engagements. Peter and his wife, Hilda, have three sons who have, or will shortly have, MBA's from top business schools. They have one grandchild.

Jack Belz is co-chairman of the advisory committee for MIT's Center for Real Estate Development. The Center conducts a unique program for 30 candidates who have had at least five years experience in real estate prior to coming to MIT. Jack's family-owned company is a founding member of the Center for Real Estate Development. They develop shopping centers, industrial parks, and commercial office malls in a number of different cities. They also develop and operate hotels including some in Boston. Jack and his wife, Marilyn, have been married for 40 years and have five children. Their three sons and two sons-in-law are all in the family business; all live in Memphis, and there are nine grandchildren with a tenth coming. Our 40th reunion was Jack's first experience with reunions and he really enjoyed himself. Many people he had been friendly with during undergraduate days also attended, and he recognized everyone except for two people.

The 1988 Presidential Citation was awarded to our class's 40th reunion gift committee. The Presidential Citation is the highest honor the Alumni Association can bestow upon any of its organizations. Emily Wade, '45, president of the MIT Alumni Association presented the Award at an MIT Corporation luncheon to **Denny McNear, George Clifford,** and yours truly who represented the gift committee. Emily joined us at our class business meeting the next day and presented the award again. The Award reads as follows: "The MIT class of 1948 40th reunion gift committee set a bold goal for its reunion gift and organized a successful campaign into which dozens of class members have put extraordinary effort. The $6.6 million dollars raised is more than twice the previous record for a 40th reunion gift.

"With a gift committee numbering 80, the Class made an effort to contact every class member in person or by telephone. As a result, more than 65 percent of the class members participated in the gift. A committee with this concentration of focused volunteer participation and level of success deserves the recognition of the Presidential Citation." **George Clifford** and his wife, Virginia, invited members of the 40th reunion committee and previous class officers to their home in Franklin, Mass. Tel and **Bob Sandman,** Judy and **Graham Sterling,** Joan and **Al Seville,** Barbara and **Malcolm Read,** Gloria and **Sonny Monoson,** Gloria and **Herb Lipson,** Ann and **Ken Brock,** Jean and **Milton Slade, Dave Cist,** and yours truly enjoyed a delightful evening. After a sumptuous meal we discussed ideas about future class activities. Everyone was prepared to pitch in and plan future reunions.

We also heard a report from **Malcolm Read's** wife, Barbara, based on the evaluation sheets returned to Malcolm at the 40th reunion. Their report will appear in a future column. **Ken Brock** suggested that a letter be sent to classmates asking for their reasons for not attending the 40th reunion. During our discussion there was strong support for sending a letter requesting classmates reasons and asking about preferences for the 45th reunion.

David Kingery retired as professor of material science from MIT after 41 years. . . . **Bob McClintock** is president of MC2 Engineering Software. They have ten years experience and 6,000 users for their software to do hydraulic calculations. The software runs on IBM PC's and compatible microcomputers. . . . **Elias Corey** was at the White House in July to receive the nation's highest scientific honor from President Reagan. Elias won the National Medal of Science for a series of striking successes in synthesizing chemicals naturally occuring in the body and in plants. Elias was 19 when he earned the S.B. in 1948 and 21 when he received his Ph.D. Both were MIT degrees.

Al Brayman died last year. No information was sent about Al. Al lived on the second floor of Wood dormitory in 1947 and 1948. Although he never said it directly, he gave me the understanding that the shocks of combat during World War II had placed a heavy burden on him. After graduation the only news from Al was an address change from the Boston's North Shore area to Kittery, Maine. I offer a prayer that his soul may rest in peace. . . . **Enrique Lima's** widow, Jacqueln, wrote recently to inform us of his death in 1985. Enrique had been president of Lima Consulting Services in San Salvador, El Salvador. . . . **Nasipak Valentin** died a year ago. He had been with GE's Military Electrical Systems in Syracuse, N.Y. . . . **John Breymann** died in April. He had retired as a vice-president of the Bank of Boston and was living in Malden, Mass.

Reggie Stoops died in September of this year. He was an avid trans-Atlantic sailor and made several trips with William F. Buckley. Reggie's obituary will be in the next column. **Frank Jones** had roomed with Reggie, and Frank is sending information about Reggie to me. On behalf of our classmates, I extend our sympathy to the families and friends of these classmates. . . . **Al Kelly's** wife died as the result of a fall down a staircase. On behalf of our classmates, I extend our sympathy to Al and his family.—**Marty Billett,** Secretary, 16 Greenwood Ave., Barrington, RI 02806

49

The June 8-11, 1989, dates of our 40th reunion move even closer while your committee redoubles its efforts to ensure that no detail escapes notice. At present (November 1988), meetings are being held monthly. Many of you received a questionnaire last September, and so far 131 have responded.

As of November 9, 59 classmates said they are coming with their spouses, while six will be alone. Some of you responded with names of people you'd like to see there, and it is the committee's responsibility, of course, to see that your wishes are complied with. **John Alger** wants **Harold Edgerton** to be there, and we'll do our best to assure that "Doc" makes it. **John Horton** wants George Bush to be on hand, and Reunion Chairman **Jim Christopher** says, "No problem." Just so happens we have a man, class president **Frank Hulswit,** who handles VIP invitations. Frank will just pick up the phone and tell President Bush where to be and when. Frank has never been turned down by a United States president.

Just in case you are interested, here is a list of those we know to be coming so far: **John R.M. Alger, Jack L. Baker, John W. Barriger, Leon Baum, Orlien N. Becker, Jim Berman, E. Milton Bevington, William R. Bohlman, Frank P. Brunetta, Marvin J. Byer, Bruce Campbell, Gunnar F. Christensen, Jim Christopher, Ove Collett, Robert C. Cowen, Russell N. Cox, Ira Dyer, John Eddy, Herbert M. Federhen, Warren C. Fisher, David D. Gaillard II, Donald L. Gillespie, Robert W. Grott, David Hardin, Archie H. Har-**

16,000 Miles by Bicycle, Sail, Kayak and Ski

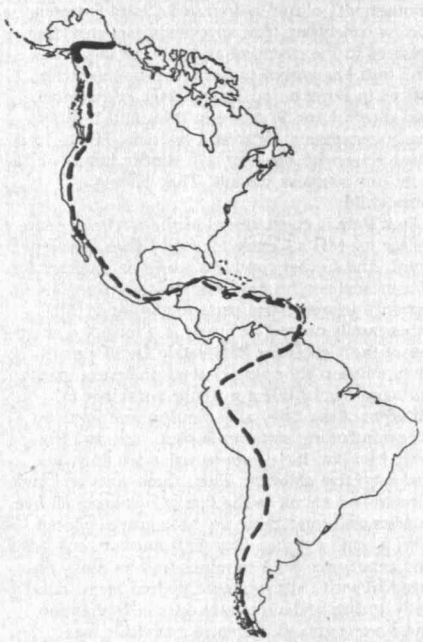


Born in South Africa, raised in Europe, Jonathan Wyss, '86, was 18 before he came to America to study at MIT. Now he'll see the American continents from head to toe and know them more intimately than a native. After he completed a bachelor's degree in earth and planetary sciences and a master's in meteorology, he embarked last June on a three-year journey from the Arctic Circle to Tierra del Fuego, by human and wind power.

This 16,000-mile odyssey will not be a direct route. Wyss's intention is "to explore the relationship between travel and the environment." His primary vehicle will be mountain bicycle, avoiding highways as much as possible. He will follow rivers by kayak and islands across the Caribbean by sail. He will also go on foot and skis, whatever is "appropriate to the place and the season." Jonathan describes his journey as one of contrasts, "from the heat of Death Valley, below sea level, to the cold wind of Aconcagua, the highest summit of the Americas."

To prepare for these extremes, the journey had to be well-planned in advance. He based his route and time schedule on weather records, a shelf of books and maps, and the advice of fellow travellers. He mustered sponsorship from equipment manufacturers, private groups, and corporate foundations. To this support he'll add his own "personal commitment, which includes work along the way if necessary." Friends old and new will accompany him at various stages and help with logistics.

Those who dream of making such a journey, but lack the means or the determination to try, have the opportunity to follow along the trail, and experience the landscape of people, climate, and geography. Part of Jonathan's daily activity is keeping a journal that is mailed in a quarterly newsletter by his supporters at home. His observations are those of an insightful and well-researched explorer. He calls his newsletter *America North South,* and it includes photographs and a hand-drawn map with weather and route information. Contributions from readers ($10 or more annually) will help defray his living expenses and the cost of shipping his bicycle and kayak to the next location where he'll need them.



As the travelogue begins, Jonathan flies into Tuktoyaktuk, or "Tuk" for short, above the Arctic Circle for a side trip "to view the Pingos," earth-covered ice mounds reaching 50 meters, before leaving from Inuvik with friend and marathon cyclist, Hauke Kite-Powell,'84. Together they ride 500 miles down the Dempster Highway leaving the Arctic Circle and the northern treeline to reach Dawson City in the Canadian Yukon. From there Jonathan departs on a week-long paddle by kayak to Circle City with Kelly Firth (now back in Boston publishing *America North South*). He concludes with a solo by bicycle on a "detour" through Alaska—west to Denali National Park and on to Anchorage, returning inland on the Alaska Highway through Destruction Bay, Whitehorse, and Skagway. In this first installment, Jonathan covered 2,200 miles in 52 days.

Selections from America North South *give the flavor of the northland and his adventure:*

"Between Inuvik and Tuktoyaktuk, there is water in any phase and any form. There are innumerable streams, sometimes short, sometimes flowing from a pond, sometimes flowing into a pond, never very effective in draining the tundra. . . .

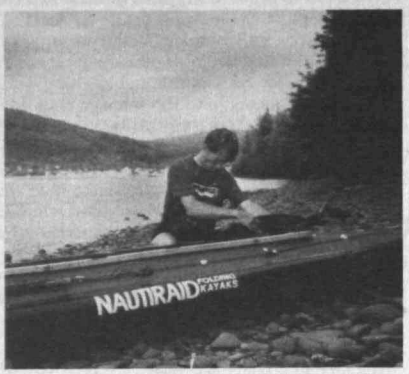
"The ecosystem of this sponge is curious indeed. Here on the tundra, sheer numbers make up for the lack of genetic diversity: by late June, the mosquito population of the Canadian Arctic surpasses that of the Tropics. Sedge tussocks, heath, and lichens form the breeding ground not only for the bugs, but also for the birds that feed on the bugs, like whales on plankton.

"Tuk sits on the edge of the sponge, on the edge of the Beaufort Sea. This town also marks the edge between northern (traditional) and southern (modern) lifestyles. . . . In the last few years, with oil prices depressed, Esso, Dome and Beaudril have all but abandoned their camps on Tuktoyaktuk Harbor. For one Inuit hunter we chatted with: 'Things are slow, but that is good. Now I have time to carve bone, and go fishing and hunting at Husky Lakes, shoot ducks with my son and clean out my yard.'

"South Central: . . . I survive, physically and mentally, by stopping periodically at the roadside cafe/gas stations that service truck drivers, fishermen, and wet cyclists. My carrot is the next mug of sugar-laced coffee. I make a detour of 15 miles on a spur road to the Talkeetna Roadhouse just for a wholewheat cinnamon bun. . . . Talkeetna is home to the glacier pilots who fly climbers up to the Kahiltna Glacier base camp.

"But the climbing season is over, and the talk today is of the new subdivision that is going up in the south of town. The young bucks in hobnail boots bolt down cinnamon buns and head out into the rain to bulldoze a new road through the willows. A new crowd comes in, and these bun eaters are less enthusiastic about the new development. They wear bluegrass festival tee shirts under the slickers, and are pon-

PHOTOS: FIRTH, KITE—POWELL, WYSS





"The Yukon is one of those crazy rivers that takes the long way down. . . ." So writes Jonathan Wyss, '86, in his journal, **America North South,** *recording the three-year journey he began in Alaska last June and will end at the tip of South America. His perambulations have a similarly circuitous quality, taking the long way by various modes of transport and lesser-known trails to traverse the continents of the western hemisphere.*

dering ways to get this winter's supply of dog food out to the cabin.

"I cross over the Big and the Little Susitna Rivers, where Anchorage fisherman stand hip to hip 'angling' for salmon on the weekends. I pass through the tiny town of Willow, where the 1976 referendum that would have transformed the site into the new state capital has long been forgotten. 'For Sale' signs now sprout in every lot. In Wasilla, home to many of the mushers who compete in the Iditarod dog sled race, [the locals] are holding a Rain Festival featuring dog hauling and howling competitions. . . .

"Anchorage hides its graying hair under a wig of flowers. They hang from lamp posts, they sprout from planters outside the million-petro-dollar buildings. The performing arts center, not quite finished, is the last ostentation. Having spent the oil money before its delivery, the city is an out-of-scale model of the Alaskan crisis as a whole.

"The Alaska Highway . . . Any tourists who demand only the finest in flying gravel, broken suspensions, mud, dust, and flat tires, can still get their money's worth on the Alaska Highway. Construction is part of the scenery. One flagwoman insists that I put the bike in a pickup truck to cross a section that has been mined with blasting caps. I insist on riding, which I am permitted to do only after being compelled to listen to an unnecessarily terrifying disclaimer.

"A Day on the Bike: The bike, a Ritchey mountain bike handmade in California, is my RV, my mobile home. . . . I am completely converted to the virtues of touring on a mountain bike. In addition to the air suspension and the ability to carry more than you could possibly carry [on a normal ten-speed] over the roughest of roads, I enjoy the upright riding position of the straight handlebars (less fatigue, and no need to consiously look up to enjoy the scenery) and fewer repairs. . . .

"Of the 50 to 80 pounds that I carry on the bike, roughly a quarter is made up of luxuries that I could live without, like a radio for the news and weather, a nylon tarp to cover the bike at night, and a half dozen film cannisters filled with spices for cooking. On the long haul, it pays to live in a civilized fashion.

"How many miles I ride and how fast I ride them depends on a number of factors: the weather (the wind in particular), the mood, the road, the scenery, the density of roadside cafes. However on an average day, which is what I am trying to describe, 50 to 100 miles feels about right. I rarely sit in the saddle for more than an hour, unless I'm in a terrible hurry.

"Camp quite often ends up a stone's throw from the road, out of sight, but close enough to get back to in case of emergency. Sometimes I camp in a campground, if there is one handy and there isn't any trash lying about. (If you were a bear, where would you hang out?) Sometimes if it is raining, I put the tent on a picnic table, where it sits perfectly level and out of the mud. The tent is made by Bill Moss. Called 'The Solet,' . . . the walls of the tent are mosquito netting, which lets the breeze and the view in and and keeps the bugs out. . . it is the most beautiful tent that I have ever slept in. . . .

"If I am feeling particularly paranoid about bears, I will hop back on the bike and ride down the road a bit before cooking dinner. . . . Dinner is delicious, no matter how burnt or bland. I eat like a moose. . . . [Cooking] pot, food, toilet kit, cup, spoon, anything with the slightest interesting smell then goes up a tree, far from camp, where I won't even know if there is a bear dancing around on tiptoes underneath the bundle . . . then back to the tent to write the day's journal entry and to listen to the radio. . . but when I turn the radio off, here in the silence of the spruce trees, there are no wars, no elections, no stock markets. I duck into the tent and the sleeping bag, and fall asleep."

If you would like to follow Jonathan's adventure through the Americas, send your contribution of $10 or more to *America North South,* c/o Kelly Firth, 440 Hanover St., 3B, Boston, MA 02113.—*Susanne Fairclough* □

ris, III, Thomas L. Hilton, Chuck Holmes, Larry Holt, John P. Horton, William C. Howlett, Frank C. Hulswit, Harold G. Ingraham, Davis B. Keniston, Geraldine Kunstadter, John W. Kunstadter, Malcolm H. Kurth, Harry W. Lambe, Robert J. Lannamann, Ray E. Larson, Peter Lehner, Albert A. Levingston, Demetre P. Ligor, Blair Manning, Stan Margolin, Jim Maslon, J. Arthur Matey, Harold A. McInnes, Gordon K. Milestone, David C. Moore, Andrew R. Pfeiffenberger, George Piness, A. Stuart Powell, L.P. "Rick" Richardson, Lewis Roosa, Harwood S. Rowles, Joseph Schneider, William C. Schneider, Nathan O. Sokal, Herbert L. Spivack, and Norman Stolz.

Peter K. Stein, president of Stein Engineering Services in Phoenix, Ariz., will be presenting some short courses in measurement engineering April 3-7, and 10-14, 1989. Peter's specialty is the electrical measurement of mechanical and thermal quantities such as pressure, temperature, flow, vibration, force, torque, stress, strain, and acoustics. Fee for one course is $1,025, while both may be taken for $1900. Engineers and managers worldwide, whose companies depend on accurate measurement and interpretation of data, flock to these courses. No impediment to registration is the beautiful Arizona weather in April.—**Fletcher Eaton,** Secretary, 42 Perry Dr., Needham, MA 02192, (617) 449-1614

50

This is an extremely busy time for information from class members. Please keep the news coming since we like to hear from you all year long. The summer period is slow, so please pick up paper and pen and tell us about yourself.

Mariano Romaquera, who is still in Puerto Rico, remains active in MIT affairs through the Educational Council and Alumni Affairs. His main interests today are real estate and venture capital. "Nano" has always kept in touch with the class and wants everyone to start thinking about our 40th reunion in 1990. He is looking forward to seeing the class of '50.

Tom Pollack, who has been on the west coast with Lockheed in Burbank since graduation, recently retired as department manager in Aircraft Structures. He is looking foward to more sailing, which he started under Bob Smith at Tech. . . . Having joined the staff at the MIT instrumentation lab right after graduation, **Peter Palmer** worked there until his retirement in 1986. He intended to stay only a short time while taking graduate courses, but he was so satisfied that he remained for 35 years.

James Monz, who continues to live in Boston, is registered as a master television technician with the Commonwealth. His main interest these days is repairing VCRs, a seemingly inexhaustible hobby. . . . **Hubert Barnes,** a professor of geochemistry at Penn State University, is the author of over 100 articles and four books. As a result of invitational lectureships he has traveled extensively, including stays in Russia, Australia, and Germany.

For the past several years **Lars-Erik Wiberg** has been investigating occupation compatibility, patterns of decision making, leadership styles, and personal values. He would like to hear from anyone who has developed interests in these areas. . . . **Friend Skinner,** who while at Tech benefited from the Technology Loan Fund, urges all who have shared in that fund to help maintain it. In a similar vein, all in the class are urged to contribute to the Class of '50 Scholarship Fund. Several of us were impressed by the students benefiting from this fund at a dinner held at the MIT Faculty Club last October.

From California, **Robert Blanchard** says that he is responsible-systems engineer for Space Telescope Communications Systems, Milstar Communications System, and Boost Surveillance and Tracking System, a part of SDI. . . . **Charles Bostick** has retired from government service after 35 years. Jogging, math problems, and recreational linguistics consume a large part of his free time. . . . **Phil Byrne** states emphatically that in his mind work was good but retirement is great. He and wife Jean enjoy their travel trailer and spend each spring, summer, and fall visiting their children and grandchildren.

Henry Sharp still has a great interest in the MIT lacrosse team. For the last several years he has helped arrange visits to his hometown of Santa Barbara, Calif., during the team's spring tour. . . . **George Costomeria** is living in Reading, Pa., and has taken as his avocation the restoration of an 1863 home. For the past several years he has been the contractor and workman in such areas as excavation, carpentering, plumbing, septic systems, and woodwork finishing. His latest project is landscaping the area. For recreation he and his wife enjoy traveling in a motor home, and this year he hopes to go out west.

We are saddened by the recent deaths of the following classmates: **William C. Morton,** Wellesley Hills, Mass.; **Arnold W. Doyle,** Weston, Mass.; and **Richard H. Holmberg,** Landisville, Pa.—**John T. McKenna,** Secretary, 9 Hawthorne, Pl., 10-H, Boston, MA 02114

51

Recipient of the 1988 Klemin award given by the AHS for notable achievement in the advancement of rotary-wing aeronautics is **Charles W. Ellis** of Boeing Helicopters. This is the society's highest honor for technical achievement. During an earlier part of his career with Kamen Aircraft, he developed the first drone helicopter and was key in the introduction of the USAF HH43B and USN UH-2 helicopters. He has spearheaded new technology and design concepts since joining Boeing in 1965. He is currently vice-president of their V-22 program. He was president and board chairman of the American Helicopter Society. He is the author of numerous papers and holds many patents in the rotary wing field. Living in Newtown Square, Pa., he and his wife Madaleen have three children.

As a featured speaker of the opening plenary session of the 1988 Materials World Congress, **Merton C. Fleming**'s topic was "An Overall View of the Materials Science and Engineering Study as It Relates to a Restructured Materials World." Living in Cambridge, he heads the Department of Materials Science and Engineering at MIT.

Having joined Fish & Richardson, the largest intellectual property law firm in New England, **Charles Hieken,** is enjoying the teaching and counseling of younger associates. Chuck's wife, Donna, is teaching and performing flute. (I heard her recently at a concert, and she is just great.) Chuck's daughter, Tina, is an M.D. surgical resident, and his son, Seth, is with a Boston bank following his graduation from Cornell.

During 1987, **Marvin L. Baker** conducted seminars in seven European cities on the problems faced by technology-based European companies in the United States. Articles about him appeared in *L'Echo de la Course* in Brussels, *Het Ekonomische Financeel Tijd* in Antwerp, *Quote Magazine* of Amsterdam, and *International Management* of London all dealing with the problems encountered by Europeans operating in the U.S. He was former president of the International Institute of Synthetic Rubber Products of North America.

Retirement, writes **Curtis Barker,** has become one of the busiest and most delightful chapters in our lives. Enhanced by our carefully designed dream house with water on two sides, they enjoy continuing visits with dolphins, manatees, pelicans, and other fish, and water fowl along with an occasional bald eagle. Along with cruising in his 28-foot Carver Flybridge Sedan, he teaches a course called 55 Alive/Mature Driving for AARP and is an arbitrator for the Better Business Bureau in disputes between automobile manufacturers and consumers.

After leaving the MIT Lincoln Laboratory, **Albert Cohen** founded and was chairman and chief executive officer of Electronic Space Systems Corp., a successful company in the aerospace ground equipment business. Traveling extensively for his company, he has thoroughly enjoyed the challenges of general and top management and is now finding time to master the game of golf. His successful marriage has provided him with three beautiful daughters who, having completed their education, are now beginning to make their contributions to society.

Serving as an elder of the Presbyterian Church since 1980 and on the board of directors of the Association of Church Missions Committee, **Herbert R. Graham** was the coeditor of *Environmental Assessment: Approaching Maturity* published in 1978. He was the author of several articles, including "Air Cushion Landing Craft Navigation," published in the *Naval Engineers Journal*.

While spending time in his condominium in Ft. Myers, Fla., **Saverio G. Greco** writes of his very special interest in horticulture (gardening). . . . Following his former position as president, chief operating officer, and director of Hi-Shear Industries, Inc., **Anthony E. Mirti** has become the president and chief executive officer of Precision Resources, Inc., of Whippany, N.J.

On a sad note, **Thomas R. Friedrich,** of Niles, Mich., died of a heart attack on June 25, 1988, while on vacation in Massachusetts. We would like to extend our condolences to his wife, Barbara. . . . Sadly, we have also received word of the passing of **William C. Griffiths** of Pottsdown, Pa.—**Martin N. Greenfield,** Secretary, 25 Darrell Dr., Randolph, MA 02368

52

I am impressed by the quantity of writing done by members of our class. Recently, for instance, **John Gaylord** completed a book, *Factory Information Systems,* published by Marcel Dekker, and **Alfred Haacke** has presented and published three papers on flowmeters. Alfred has written 30 research papers so far. He says he is now thinking about mathematics and its relation to physical reality, and the relationship between math and language. . . . **Charles Hecht** is also the author or coauthor of 30 papers in physical chemistry and chemical physics, with emphasis recently on phase transitions and critical phenomena. (You remember Professor Sears heating the tube of carbon dioxide through its critical point in freshman physics lecture). Professor Hecht is also the prospective author of a textbook. . . . **Payson Palmer** has presented several technical papers to various marine engineering societies and trade publications. Finally, retired Col. **Dan Lufkin** is an active free-lance translator of German.

Howie Zasloff writes that he took early retirement from a division of Combustion Engineering three years ago and is now building up a consulting practice with a group in petrochemical plant design and operation. . . . **Palmer Shannon** has a second business—antiques.

Financial planner **Robert Norton** and his wife Ginny, of Holliston, have seen the last of their eight children graduate from college. All their children live in the Boston area, so they are together often. They have 14 grandchildren. In addition to being very active in his business, Bob has participated in local church and school activities and is currently active in community and business affairs.

The chairman for our next reunion, **Bob Lurie,** feels a close family relation to MIT. His father was a member of the class of '21, and his son-in-law is a member of the class of '78. Bob's daughter Rachel and her husband have made Bob and Nancy grandparents for the first time, and Bob wonders if his new grandson will be a fourth generation MIT student.

David Kessel writes that he was amazed to be invited to speak at a joint MIT-Harvard symposium. He attributes the invitation to the probable retirement of all his former teachers in both

places.—**Richard F. Lacey,** Secretary, 2340 Cowper St., Palo Alto, CA 94301

54 35th Reunion

Sometimes the news about our classmates is not easy to report. We have gotten notices of three deaths in the class. **Theodore Gerken** died almost two years ago. He lived in Trexlertown, Pa. No details are known. . . . **George Dormer,** who ran his own company in New York City, died last September of cancer. . . . **Bill Steyert** died in May 1988. Bill was a senior research associate for Air Products & Chemicals, Inc., in Allentown, Pa. Our sincere sympathy goes to Barbara Gerken, Sydell Dormer, and Lila Steyert.

Our reunion plans are proceeding nicely. We hope to see all of you in Cambridge June 8-11.—**Edwin G. Eigel, Jr.,** Secretary, 33 Pepperbush Lane, Fairfield, CT 06430; **Joseph P. Blake, Jr.,** Assistant Secretary, 74 Lawrence Rd., Medford, MA 02155

55

Thomas Marlow brought us up-to-date on his life. He has spent over 2 years with the Bechtel Group involved in planning, design and building civil projects in the United States, South America, Antarctic, Middle East, Central America and New Zealand. Tom recently moved to the NYCTA as chief engineer. He says it is very exciting to participate in a significant and challenging Capital Improvement Program to bring the subway and bus systems into a state of good repair and reliability that will be attractive to an increasing ridership. He also is enjoying living in Manhattan and taking advantage of the City's many offerings. Tom is thriving on watching his girls grow up and is enthusiastic about being a grandfather.

Richard Rush reports that he is very active in church, Boy Scouts and the CAP. He is a certified flight instructor on single and multi-engined aircraft plus instruments. Richard speaks with pride about his children and the fact he has six grandchildren. Richard Jr. graduated with honors in mechanical engineering from Georgia Tech and is a drilling supervisor for EXXON in New Orleans. Gary graduated from Purdue with straight A's in electrical engineering and became president of a software company at age 29. Alison lived three years in Germany and is now back in Valparaiso, Ind., with three beautiful little girls.

Rodman Joblove gave a fascinating chronical of his life and times to convince us he hasn't done anything special. Listen to this, I quote: "Essentially, my entire career has been in R&D for the USAF at Wright-Patterson AFB. Did my job well enough, but never did anything special. . . mainly because I was doing too many other things. I'm surely a jack of almost everything, master of nothing! While at W-AFB I have done everything from being a technical editor to working in flight and engine instrumentation, electronics systems, advanced flight vehicles, nuclear weapons effects, and advanced structures, both metallic composites as well as composite repair techniques.

"On the lighter side, I raced sports and formula cars from 1952 through 1965 (lucked out—had a rich sponsor). I have been a wilderness backpacker since 1963. Was a sailplane pilot for about four years. Have been an avid ballroom dancer since 1961, spending 12 of those years as a part-time teacher. Managed to go out with a bang. My last competition, March 1988. . . got one second and ten firsts in eleven events. Good way to quit! I have dabbled in such things as hang gliding and sky diving. In 1977-78 I was building a full-size airplane but gave that up when I took up one of my biggest passions-whitewater kayaking. That has dominated my life these last 10 years and wish I had gotten started 10 years earlier. I'm also a solid S-F fan and also read lots about astronomy and cosmology. Some day, I may even get to *really* understand relativity and quantum physics! I try, but the concepts and math are far out!!! I have also done many crafts and hand-skill hobbies all my life.

"As of July 2, 1988, I am retiring and will NOT go to work for a contractor, etc. . . . I am selling my house and most possessions. Then I load up my van and essentially become a 'Road Bum'! I do plan to spend about a year as a volunteer worker at the University of Hawaii's Kewala Basin Marine Mammal Lab. I worked there in 1987 as an Earthwatch volunteer on their dolphin cognition and language project. Loved it so much (the four dolphins are fantastic and loveable) I have to spend more time there. Hawaii isn't hard to take either. . . plan to do lots of snorkling, scuba, surfing, outrigger canoe racing, and backpacking. An old friend of mine even owns a dance studio in Honolulu! Then. . . on to Australia, New Zealand, Alaska, or wherever my nose happens to point." Whew, see what I mean!

Roger Reiss sent an excerpt from a course that he is teaching that gave a good summary of his life to date. He has spent most of his 30 years as a mechanical engineer in the electro-optics field. Roger is with Lockheed Missiles and Space Co. He received a B.S. in Course II and completed post-graduate studies at Northeastern University and was an instructor at Northeastern of state-of-the-art courses in precision instrument design. Roger is currently the organizer and first chairman of the new opto-mechanical engineering working group of the SPIE's newspaper.

Bob and I appreciate all the news everyone sends along so we can have a full and interesting column. Keep up the mail so we can bring the news to everyone.—Co-secretaries: **Robert P. Greene,** 37 Great Rock Rd., Sherborn, MA 01770; **DuWayne J. Peterson, Jr.,** 201 E. 79th St., New York, NY 10021

56

Ten classmates (and two members of the Alumni Association) attended the first formal class meeting, since the wrap-up of the 30th reunion, to discuss outstanding items plus initial plans for the 35th reunion. The class has received several letters thanking us for the 25th reunion gift to establish the career Development Professorship. This is a $250,000 perpetual professorship, based on the interest of the principal. **Ron Massa** class president will be sending you a letter to thank you and to let you know how this gift benefits MIT and us.

What should be our next goal/objective for our class gift(s)? Would you like to be active in determing such? If so, contact **Ron Massa** (Lorron Corp., 44 Mall Rd., Suite 203, Burlington, MA 01803, (617) 229-7844). It proves of merit that our gift reflect the desire(s) of our class. Where and when should our 35th be held? Initial planning is required to ensure a good reunion. A non-binding referendum was taken at the subject meeting, and it opted for a campus-oriented three-day reunion in the fall. A program was proposed where local alumni host alumni not from the area. Any thoughts should be directed to **Lloyd Becket,** 6 Radcliff Circle, Bedford, MA 01730, (617) 275-5234, or **Ted Korelitz,** International Trade Management Corp., 136 Beethoven Ave., Waban, MA 02168 (617) 969-8540.

At every reunion there is talk of "let's get together." Mini-reunions provide a good opportunity to get together for personal, business, and other reasons (such as to formulate some of your feelings in the above column). A mini-reunion was discussed for the Northeast centered around an MIT football game or the Head-of-the Charles Regatta. The addresses of classmates in your area can be provided for a get-together in your locale.

Those in attendance at the referenced class meeting were **Warren Briggs, George Brattin, Petter Fulchinos, Bill Grinker, Ted Korelitz, Klaus Kubierschky, Paul Lempel. Ron Massa, Bill Northfield,** and **Harris Weinstein.**—Co-secretaries: **George Brattin,** 39 Bartlet St., Andover, MA 01810; (508) 470-2730; **Irwin C. Gross,** Sweet's, McGraw-Hill, 1221 Ave. of the Americas, New York, NY 10020, (212) 512-3181

58

Well, shiver me timbers, lads! It's winter here in Wisconsin—also known as the "blue zone" on your full-color weather map. To keep you warm, though, here is the latest news from classmates around the country.

During 1988, our very own **Tom Magliozzi** and his brother Ray, '72, received lots of publicity for their radio show "Car Talk." They appeared on all three TV networks, including 20/20 with Hugh Downs and the *Sunday Today Show* with Maria Shriver. Since 1976, Tom and Ray—a.k.a. Click and Clack, the Tappet Brothers—have been serving up car-repair advice with a liberal dash of irreverent humor. Heard locally in Boston for about 10 years, "Car Talk" is now heard throughout the country on National Public Radio. Beyond the airwaves, Tom teaches marketing at Boston University where he is also a doctoral candidate. Tom and Joanne have two children, Alex and Anna Kate.

Travis Amis advises that he retired several years ago from his position as vice-president for a Caterpillar dealer. According to Travis, "I spend most of my time sailing in Florida and the British Virgin Islands or else stewing about the stock market." . . . **Norman Hammer** served as moderator for one of the technical programs at the Centennial Celebration of the American Society of Naval Engineers.

Dan Brand, vice-president of Charles River Associates, was named chairman of the National Research Council's Transportation Research Board Task Force on Advanced Vehicle and Highway Technologies. This task force will address the use of new technologies, such as highway route guidance systems, to reduce urban traffic congestion. . . . **Roger Kapp** has joined American Home Products Corp. as senior vice-president and general council. Previously he was a partner with the firm of Donovan Leisure Newton & Irvine in New York.

As promised, here is some news gleaned from classmates at our 30th reunion. . . . **Arthur Fiorelli** is currently director—New Business Development, Resins Division, at Monsanto Chemical Co. He has been with Monsanto since graduation and started in manufacturing technology and process systems at the Springfield, Mass., plant. Later he became director of R&D of the Coated Resins Business. In 1986 he was promoted to his current position. . . . Karen and **Bob Schmidt** attended the reunion with their daughter Erica, 16, and son Peter, 13. Bob is currently with Boeing Aircraft in Seattle as a senior principal engineer in the shock physics group. . . . Although this was their first reunion since graduation, Tina and **Charlie Robbins** promised to be back for the next one. Charlie is currently executive vice-president and general manager of the Electron Devices Division of Varo Corp. He has two children, Cathy and Sharon. Continuing the engineering tradition, his daughter Cathy is studying mechanical engineering at Cal Poly.

Pete Hellsten is now chairman—Aircraft Engineering Technology, at Embry-Riddle Aeronautical University in Daytona Beach. Karol and Pete have three children, a son Chris, daughter Kristi, and another son Curt. Both Pete and his son Chris race outboards in their spare time and Pete is currently national champion in the Service Class. Among Pete's students at Embry is Christopher Phinney, son of **Bob Phinney.** . . . **Paul Busch** was recently named president of Malcolm Pirnie, Inc., a leading consulting environmental engineering firm. At the same time, Paul was named president of the American Academy of Environmental Engineers. Paul's wife, Iris, has become a business entrepreneur and currently has four video stores in the Wilton, Conn., area. . . . **Bud Medeiros** is with the Transportation Systems Center in Cambridge, Mass., where he is

involved with applying computers to air-traffic flow-control problems. Bud is working on development of systems that can monitor and perform predictive analyses on flight patterns throughout the U.S. At the reunion, Bud said that he and his wife, Marge, may have the unique distinction of still living in their first house. Their three children are all married and they currently have two grandchildren.

Until the reunion, we hadn't heard much from **Steve Sanders,** who is alive and well and serving as president and general manager of Northern Arkansas Telephone Co. Steve assumed his position with this rural, independent telephone company in 1977. For the previous 14 years, he taught physics at Southern Illinois University. Prior to that he was at Princeton's Forrestal Research Laboratories working in plasma physics. Steve has his own plane and flew up to the reunion in his Cessna 182. . . . Another member of the class of '58 flight crew was **Jack Connor,** who flew to Martha's Vineyard in his Cessna 134. Jack has retired as chairman of the board of Sewell Plastics, a major manufacturer of plastic bottles for soft drinks and other beverages. Among Jack's hobbies is antique-car collecting—he has restored about 14 cars over the past dozen years. Jack's wife, Pat, is also a private pilot and they have taken a number of lengthy trips together. And speaking of long trips, Jack soloed the Atlantic Ocean in 1987. Shades of Lucky Lindy.

Still more reunion news next month. Keep the home fires burning.—**Michael E. Brose,** Secretary, 841 Magdeline Dr., Madison, WI 53704

59

Can you believe that our 30th reunion is less than six months away! A wonderful program is being planned by **Dave Packer** and his reunion committee. From all indications, we should have a "simply mahvelous" turnout. The reunion will be held at the magnificent Ocean Edge on the north shore of Cape Cod the weekend of June 9-11.

A back of the pledge envelope note from **Jim Snodgrass** informs us that, along with a group of investors, he recently purchased the Stiffel Co., the leading U.S. lamp company. Jim is serving as chairman. . . . A press release from the National Academy of Engineering announces the establishment of a major international award for achievement in engineering and technology endowed by the Draper Laboratory for achievements "contributing to the advancement of human welfare and freedom." The first biannual prize will be awarded in October 1989 consisting of a gold medal and $350,000 in prize money. One of our classmates, **Dan Wang,** professor of biochemical engineering at the Institute, has been named a member of the prize committee which is chaired by Robert Seamans, former Secretary of the Air Force. Any ideas of fellow '59ers who should be nominated?

My sincere warm thanks to **Steve Parkoff** who sent me a lengthy and newsy letter from which I will excerpt the highlights here. Steve left Revlon last June after 18 challenging and exciting years during which he was senior director of marketing and sales administration for the fashion and designer group. He is now manager of sales and marketing for Coopers and Lybrand in New Jersey. His son Seth graduated Lehigh and is now in the U.S. Air Force stationed at the L.A. Space Station working on mobile radar stations. His middle daughter, Susan, just graduated from Carnegie Mellon with a degree in fine arts and is currently employed by an office interior decorating firm. His youngest daughter, Heather, spent one year in Israel and is now a freshman at Brandeis. Steve's wife Barbara is employed by the state of New Jersey as a gerontological planner. We will all be needing her services soon.

Jim Rogers writes from Woodland Hills, Calif., to let us know that he has been promoted to chief scientist, Space and Strategic Engineering Division of Hughes Aircraft Co. Jim has been with Hughes for over 25 years. His son Steven also works at Hughes. His daughter Valerie just graduated from UCLA and is working for Optical Coating Laboratory, Inc., in Santa Rosa, Calif. Jim also informs us that he and his wife Cynthia celebrated their 29th anniversary last October.

On a final sad note, I recently received an obituary from the *Portland* (Maine) *Press Herald* which reported the death of **Larry Laben** from cancer. At the time of his death, Larry was a program manager for the IBM Corp., White Plains, N.Y., where he had worked for 25 years including two assignments in Japan. Larry is survived by his wife June, a daughter, a son, and his mother. I remember talking with Larry and June at **Phil Richardson**'s wedding in NYC and listening to their interesting stories about their experiences in Japan. Larry was a warm and personable fellow and he will be missed. Our heartfelt sympathy goes out to June and the other members of Larry's family.

Ron Stone and I would like to remind you to continue to send us your news so that we can continue to fill up this space every month.—**Arthur J. Collias,** Co-secretary, 24 Hemlock Dr., Canton, MA 02021, (617) 828-5073

60

Noel Bartlett sends "best to everyone" from Cleveland, Ohio, and says that he is still with Sohio Oil. Noel and Kathy celebrated their 25th anniversary in 1987. Their daughter Sara was married in August 1987 and elder daughter Rebecca is a second-year law student. . . . **Robert E. Gold** writes that he is moving to Israel where he will be working for the Israel Geophysical Institute in Jerusalem. . . . **Lawrence Kravitz** is in Aberdeen, Md., working at the Army's Aberdeen Proving Ground as an analyst on tank survivability. He reports that all is well with him, Yvette, and their daughters.

I sadly report the death of two of our classmates. . . . **James K. Okazaki,** who was living in Seal Beach, Calif., died in August. He is survived by his wife, Joyce, and son, Neil. . . . **Samuel A. Latt,** M.D., who was a professor of pediatrics and genetics at Harvard Medical School, died unexpectedly August 28. Sam is survived by his wife, Barbara, and daughter, Allison, of Newton, Mass.—**Frank A. Tapparo,** Secretary, 15 S. Montague St., Arlington, VA 22204

61

Andy Zeger writes that he was not happy to hear that varsity football had come to MIT. His point is that money would be better spent on R&D, UROP, and intramural sports. He goes on to say that if we are not careful we will replace Columbia as the wimp of football. "Women are a major part of MIT now and I don't think they'll benefit from varsity football at all. Did MIT really need a 36th varsity sport?" asks Andy. Any other opinions out there? Are you in favor of the Fighting Varsity Beavers or not?

Whatever we think about football, we certainly have been getting a lot of calls and letters asking for money for the ole' toot. The other day I got a letter from Lawrence Dunn, '83, asking me to tell you about his proposal to set up an alumni-sponsored scholarship fund to help needy undergraduates. He obviously did not ask anyone at MIT whether someone was doing that already, or he would have known that our class gifts usually go to scholarship aid. He has reinvented the wheel.

Haskell Rosenthal wrote us a nice note in which he said, "In September 1987, I was appointed the initial holder of the John T. Stuart, III, centennial professorship in mathematics at the University of Texas, Austin. I am chairman of the organizing committee for the microprogram on the structure of Banach spaces, which took place last summer at the Mathematics Science Research Center, Berkeley. This fall I'll be on leave doing research at the IHES, Bures-sur-Yvette, France."

Sheila Widnall is on a National Academy of Engineering committee to select a winner of the academy's biennial Draper price for engineering and technology achievement. The prize comes with $350,000, a gold medal, and, one supposes, a great deal of publicity. It's about time you engineers got the recognition you deserve. Nominations come from all over. If you are a member of an engineering society you can probably put in your 2-cents worth. The address: NAE, 2101 Constitution Ave., Washington, DC 20418.

There are plenty of awards in place already. . . . **Alan Oppenheim,** who is professor of EE and CS at MIT, got the IEEE Education Medal last May. The award honors Alan's "leadership in engineering education through teaching, textbooks, and videotape lecture series in digital signal processing." Congratulations, Alan.

John Deutch may not be going to Washington in a Democratic administration but he is now on the White House Science Council. Whether he remains in the Bush administration will be noted here.

Here are recent changes on the corporate scene. **Dayle Verber** is a real big honcho. He is chairman and chief executive at Equitec Financial in Oakland, Calif., and has the same position with PacificCorp Financial Services in Portland, Ore. Since the second company owns the first, there is no conflict of interest. A clipping says that **Richard Spann** resigned from his chairmanship at Adage, Inc., in Billerica, Mass., last June but doesn't say why.

The mail has been pretty sparse lately. Sit down. Write. That's an order.—**Andrew Braun,** Secretary, 464 Heath St., Chestnut Hill, MA 02167

62

The word from the West Coast is that **Bret (B.T.) Tucker** is currently president of Ergo, Inc. Bret lives at 1419 Wyant Rd., Santa Barbara, CA 93108. . . . **Richard N. Sutton** is a practicing physician in Wichita Falls, Tex., with specialization in diagnostic radiology. He is proud of the fact that he has not suffered a legal setback and hopes to live long enough to see Medicare repealed. We hope that if he does live that long that he, as well as the rest of us, will have something other than Medicare to depend on! . . . **Herb Taylor** was with IBM for 15 years before leaving to follow his entrepreneurial spirit and form several of his own business firms. We'd like to hear from Herb, who now lives in Framingham, Mass., about his firms and their activities.

Pandelis Velissaropoulos, now vice-president for marketing with the Chronar Corp., was technical director of Elusis Shipyards during the time they were building some of the largest offshore oil platforms in Greece. Pandelis now lives with his wife, Margot, and their two children, Stephanos and Arianne, in Belle Mead, N.J.

The Pro-Life (anti-abortion) forces have a strong ally in **Larry L. Stine,** who hopes someday to see a human life amendment to the U.S. Constitution. Larry is telecommunications group leader with the Mitre Corp., and is celebrating his 25th year with Mitre this year. He and his wife, Mary Kay, (with one year of seniority over Mitre in claiming Larry's affections), and their children—Christopher, Michael, William, Daniel, Laura, and Benjamin—are based in Herndon, Vir. Larry is a board of the Virginia Society for Human Life and is chairman of their political action committee.

Jeff Steinfeld went up the river to get his Ph.D. in chemistry at Harvard (he admits to having that skeleton in his closet) and now serves as a full professor in the Chemistry Department at M.I.T. Don't feel too bad, Jeff, there are at least a dozen classmates with M.B.A.'s from Harvard, and even your class secretary was a visiting fellow with the

Economics Department over there during 1987.

Steve Smith lives in Sewickley, Pa., with his wife, Becky. Steve is president and chief executive officer of Ryan Homes, Inc., and serves as a director of Union National Bank in Pittsburgh. He has served as a trustee of the D.T. Watson Rehabilitation Hospital, a director of the Pittsburgh Public Theater, and a member of the Salvation Army advisory board and the Edgeworth Planning Commission.

Herb Selesnick and his wife, Hinda K. Sterling, are living in that pleasant north shore community of Beverly, Mass., and are co-creators of the syndicated comic strip, *Stockworth*, about the life and times of a corporate chief executive. Their work appears in 70 newspapers across the land with a readership of over four million. Herb is a management consultant, president of Sterling & Selesnick, Inc. (we assume Hinda is CEO and chairs the board of directors), as well as president of Salem Door & Window Co., Inc., remodeling distributors in nearby Salem, Mass. Herb looks forward to publishing an anthology of the corporate comic strip and to becoming wealthy enough to spend money with the same ease as his three daughters.

We can always use the news about your interests and activities. We can even give advice to the lovelorn and comfort to the lonely through this column dedicated to our classmates. Just write to "Dear Hanky Poo," c/o **Hank McCarl,** Secretary, P.O. Box 352, Birmingham, AL 35201-0352

63

What a wonderful time of year to write your devoted class secretary, especially since the mailbag is empty. I can report that today, the day before Election Day, our daughter Julie is absorbed in staring at TV, doing her own variety of Tai Chi, smiling, and uttering phoneme salad—all of which suit nicely a ten-week-old. My son Gary, somewhat more advanced in years, is busy applying to graduate schools and doing his senior thesis. And Linda and I are savoring the role of doting parents. I would be pleased to receive your dispatches.—**Phil Marcus,** Secretary, 3410 Orange Grove Ct., Ellicott City, MD 21043, (301) 750-0184

64 25th Reunion

I regret that the column this month is necessarily a sad one. During the summer of 1988, two of our classmates, **Jerry Luebbers** and **Gordon Nelson,** passed away.

Jerry died unexpectedly on August 12 at the age of 46 at his office in Evanston, Ill. He was owner and chief officer of the American Science Center and of Jerryco. Jerry served the class of '64 and the Institute well as undergraduate association president. After graduating from Course XV and earning an M.B.A. from Harvard, Jerry took over the surplus optical equipment business started by his father and expanded it into a multimillion dollar enterprise. He was an active art collector and supporter of the Society of Contemporary Art at the Art Institute of Chicago. At the time of his death, Jerry lived in the near north side of Chicago. He is survived by his wife, Claudia, his parents, and a brother.

Gordon died on September 18. He graduated from Course VII and later got involved in developing specialized communications systems, among other activities. Gordon was for a time several years ago a colleague of mine at TASC. His energy and creativity were virtually unlimited. Later, he went on to start his own company. At the time of his death, he lived in McLean, Vir. He is survived by his wife, Susan Hopley.

I'm sure that I speak for the entire class in expressing our sincere condolences to the families of Jerry and Gordon.—**Joe Kasper,** Secretary, 3502 Idaho Ave., NW, Washington, DC 20016

66

Sorry there was no column last issue but there was no news. We know you're out there—let your classmates know what you are doing.

Tom Franzel writes that a seemingly perpetual "work in progress" is finally seeing the light of day. His long essay on natural philosophy appears in a new Canadian journal, *Physics Essays*, in two parts (September and December).

The American Chemical Society reports that the Joel Henry Hildebrand Award in Theoretical and Experimental Chemistry of Liquids has gone to **David Chandler.** . . . **George Berbeco** addressed the International Conference on Modern Electrostatics in Beijing, China, in October. . . . **Frank Di Salvo** recently led a discussion panel at the Welch Foundation Conference on Chemical Research. His research focuses on new chemical and physical phenomena in solids.—**Jeff Kenton,** Secretary, 7 Hill Top Rd., Weston, MA 02193

67

Ruth McDowell's quilt, "Quiet Places," was on view last summer at an art gallery in Lexington, Mass. Ruth's quilts have won many honors and have been exhibited throughout New England and New York. . . . **David Griffel** has planned, as of last July, to have his name placed as an independent candidate for the United States Senate seat from Massachusetts.

The MIT class of 1969 is having its 20th reunion June 9-11, and is inviting proximate class members to their reunion activities. Those of you who would like further information should contact Ms. Eliza Dame at the MIT Alumni Association, (617) 253-8230.—**Jim Swanson,** Secretary, 878 Hoffman Terrace, Los Altos, CA 94022

69 20th Reunion

Your notes being notably few again, I'll have to resort to quoting from a corporate press release, to wit: **Richard L. Mazer** has been admitted to the partnership of Touche Ross & Co., a "Big Eight" accounting, tax, and consulting firm. Mazer, a management consultant in the northern California practice, is the firm's national director of mergers and acquisitions in the food industry. His areas of specialization include corporate finance, strategic planning, and financial consulting for companies in the food, retail, software, real estate, health care, and computer industries. Richard began his career with Touche Ross in 1983 as a senior management consultant. He lives in Half Moon Bay, Calif., with his wife, Diane, and their son.

A sad item—Ben Roberts, '71, informs us of the death of **Mark Swift.** Ben's letter, in part: "Mark died after a long struggle with cancer on July 28, 1988. Mark was always dedicated to being the best, against all odds, if necessary. He approached his illness in the same manner and set for many of us an example of dedication, strength of will, and determination.

In his last years, he was a successful consultant for business and government in energy systems modeling and planning, a vintage race car driver, a marathon runner, and a friend to many. He is survived by his wife, Darlene DeLancey. A memorial scholarship fund has been established in his name for nursing students seeking to work with the terminally ill. For those interested in remembering Mark through that fund, the address is: Samuel Merritt College, c/o Ms. Jan Stamos, 370 Hawthorne Ave., Oakland, CA 94609.

I wrote this last time, but it bears repeating: By now, you all should have received our preliminary mailing or mailings asking you to come to our 20th reunion, June 8-11, 1989. Please come!—**Eugene F. Mallove,** Secretary, 183 Woodhill-Hooksett Rd., Bow, NH 03301

72

Ed Rich has been named treasurer for Mideast, Africa, and Eastern Eruope for Dow Chemical. He has been an attorney with Dow since 1979. . . . **Ray Magliozzi** runs the Good News Garage in Cambridge and is a host along with his brother Tom, '58, of National Public Radio's "Car Talk."

Steve Perrenod writes, "My wife, Yuriko, and I will be leaving for London in January. I have been named European technical marketing manager for Alliant Computer Systems, a leading manufacturer of parallel and vector processing mini-supercomputers and scientific visualization systems. We are both greatly looking forward to the opportunity to live and travel in Europe and to European economic developments leading to 1992. We are brushing up on our French. After my hectic Japanese assignment, I'm hoping this will be a bit more relaxed. I suspect the reality will be otherwise. I was back in Cambridge last month and took some slides around MIT, which is one of our larger accounts. It's always pleasantly nostalgic to walk through the halls of the 'Tute." . . . **Duncan Allen** is relocating to the Boston area. "I will be continuing work on the T rapid transit control center and on an extension of commuter rail from Ipswich to Newburyport. I'll be keeping a hand in on the Baltimore central light rail line via long distance commute and will contribute to various highway projects."

Finally, a sad note from **Jerry Zuckier.** "Residents of Bexley and assorted hangers-on during the early to mid-seventies will be interested to learn of the death of my dog Bozo at age 16 of a cardiac tumor. Those familiar with his exploits (including climbing the little dome, hijacking the remains of a cow leg after the freshman barbeque and carrying it off to Kresge plaza despite serious enemy pursuit, and the infamous tunneling under-the-seats escape in 10-250 during an LSC movie) will not be surprised to learn that he left this life with a smile on his face and a (feeble) wag of his tail looking forward to the NEXT BIG INTERESTING ADVENTURE."—**Dick Fletcher,** Secretary, 135 West St., Braintree, MA 02184

73

One message and a letter to pass along to you this month. **Steve Hansen** was one of three recipients of the Marcus Grossman Young Author award presented by ASM International. Steve, who is supervisor of the Steel Products Development Group for ASM, was honored for a paper published in Metallurgical Transactions in February 1987. . . . **Gints Berzins** atones for 15 years of informationlessness with a letter. Gints, wife Mara, and young Eric ('08) live in Greenwich, Conn., where he is working as president of New York's Kagan Financial Group. Kagan is invested heavily in the cable TV, broadcasting, and publishing industries. On the side, he's living the outdoor life, canoeing with 2-year-old Eric, windsurfing, scuba diving, and the like. Gints encourages contact from classmates.

My Eric ('96) is slightly older, having just finished freshman football season as a defensive tackle. Those of you who remember me as an undergrad are really scratching your heads over that one, I'll bet. JR ('03) is cub scouting, and the little wife is bowling better than ever, as witness of her 265 game in league last week. Ruth and I belong to an amateur tour in the metropolitan Washington area, and after 11 tournaments she's about $500 ahead of me. Write!!—**Robert M.O. Sutton, Sr.,** Secretary, "Chapel Hill," 1302 Churchill Ct., Marshall, VA 22115

74 15th Reunion

Fellow campers, have you noticed how close to the middle of the Class Notes section we are? And speaking of reunions, I had a phone conver-

sation with **Jerry Jungster** about that very topic. He followed up with a letter that nicely expresses two important sentiments. "I had a wonderful time at the 10th reunion. . . . I got to know classmates whose faces I had seen literally hundreds of times in the Institute corridors in our four years, but whom I never had an appropriate occasion to meet. After the fact, I learned from some people that they were reluctant to attend because they felt that they might not measure up to their more 'successful' classmates. Setbacks in life? Most of us have had them; you're not alone. I spent a brutally long time in graduate school: not one, but three dissertation topics dissolved before my eyes. I did finally muster up the heart to see a fourth topic to a successful conclusion. As for the 10th reunion, we had a good time; and the last thing that we did was to 'keep up with the Joneses.' It's you, and where life has taken you, and what you've learned that will be valued. So don't let any hesitations keep you from coming this time. Be good—and be there at the 15th!"

The carrier pigeon from the Left Coast brings a 'gram from **Paul Schindler.** Paul's moved to *PC Week* magazine, where he writes a regular column in the management section of the paper. Look for his picture. . . . **Michael Jacobson** has become president of Vetco Gray, Inc., of Houston. . . . "I left the Social Security Administration this summer," writes **Bruce Schobel,** "to become senior consultant at Mercer Meidinger Hansen, Inc., the largest compensation and employee benefits consulting firm in the world." Bruce likes Louisville compared with the Baltimore-Washington area, and "the private sector doesn't change all of its top management periodically, like the government will do in 1989!"

Barry Buchbinder says this has been a busy year. He and Isabelle have their first child, Joanne Rae, as of April. Late in August, Barry's Agrigenetics Madison (Wisc.) laboratory was shut down, leaving him looking for work writing biotechnology patents. Hope the news is better by now. . . . **William Gardner** has moved still further from Boston. Leaving Hong Kong, Bill is now working as the director of an English Training Center at Changchun University in northeast China. Bill writes, "If you saw the film The Last Emperor, you saw the city I lived in." Bill was almost in the movie.

Don't miss your chance to be in the movie. "The 15th Reunion" starts filming in June, directed by **Steve Bates** with an all-star cast.—**Lionel Goulet,** Secretary, 115 Albermarle Rd., Waltham, MA 02154-8133, (617) 899-9694

75

Harlan R. Davis writes, "My career as an airline pilot has, in just the last few days, taken a major step up. On the 18th of July, I began ground school for the position of Captain and, as of the 27th of September, achieved that position. I fly 36 passenger shorts 3-60 out of O'Hare airport in Chicago. Contrary to what you might think, driving to and from the airport is far more frustrating and time consuming (and dangerous) than flight in and out of O'Hare." Congratulations, and see you in the air. . . . **Scott E. Denmark** of the University of Illinois is an ACS 1989 National Award Winner.

Matthew E. Farber forwarded a copy of a paper authored by him that appeared in the September 1988 issue of *Ophthalmology* entitled "Increased Mortality Rates After Cateract Surgery." Writes Matt, "I have been able to use my quantitative skills and background in health planning while practicing medicine. Evaluating health policy and performing eye surgery may be the epitome of 'mens et manus'." Matt is currently at the Santa Barbara Medical Foundation Clinic in the Department of Ophthalmology and Ophthalmic surgery.

From the News Release corner, I've learned that **Mark R. Hurwich** has joined The Wilkerson Group (TWG) as vice-president. In this position Mark will consult on organizational effectiveness and planning as well as augment TWG's own management. TWG is the largest management consulting organization in the United States exclusively serving health care firms. According to the release, Mark is an author and a lecturer and has been quoted in a variety of publications, including *Business Week* and *The Wall Street Journal.* He is at present writing a chapter on "specialized industry options." He is at present writing a chapter on "specialized industry options" for *The Handbook of Venture Capital, Mezzanine Investing and Entrepreneurship* and will author portions of a forthcoming American Management Association book on sales management.

Alfredo A. Czerwinski was appointed medical director of the Kelsey-Seybold Clinic of Houston, Texas, as of September 13, 1988. . . . **Benjamin Netanyahu,** who served four years as Israel's ambassador to the United Nations, was the leading vote-getter when the main faction in Israel's right-wing Likud bloc chose parliamentary candidates in July in preparation for November elections. The Likud bloc shares power in Israel with the left-leaning Labor party and hopes to defeat Labor in November with its slate of candidates.

I received a much appreciated note from **Wesley Blank.** He had this to say, "Nan and I had another baby girl, Rebecca, to join our two others, Leah and Hadass. It's because I became a certified Mohel." Incidentally, his new business address is, Chelmsford OB/GYN, P.C., 3 Meeting House Rd., Chelmsford, MA 01824.

That's all folks. Keep writing.—**Jennifer Gordon,** Secretary, c/o Pennie & Edmonds, 1155 Avenue of the Americas, New York, NY 10036; or 18 Montgomery Pl., Brooklyn, NY 11215

76

Please write or call. We desperately need news. From what little mail we have: **Carl Thompson,** an associate professor of electronic materials in the department of Materials Science and Engineering at the 'Tute has been granted tenure. He developed a fundamental materials-science underpinning for thin-film processing and specific technical achievement in controlling microstructures of thin films for electronic-device applications.

From **Robert Chen:** "I'm keeping busy at the Alan Shawn Feinstein World Hunger Program at Brown University. Our son, Bryce, now one year old, is walking and very active—a miracle of modern medical technology! He's now more than five times his birthweight of 2 lbs., 10 oz."

Our apologies for proofing problems to Lenny Davis, '74, a friend of your secretary's from our common home town, Milton, Mass. He married Linda, not Leslie, Freeman.

As for your secretary, he is starved for news of classmates. Plenty of news of the goings on of the world pass by my desk, by virtue of an electronic news ticker which sits on it. But I do not have such a devise for tracking developments with our class. Please write, especially since many of you have written six to ten years ago. I am sure much has happened to you since then.

The news from the world continues to create turmoil and volatility in my markets. From my perspective, up has become down, left, right, as we move in and out of the dollar, among other futures. However, I have begun branching out a bit, back into real technology. (Futures is financial high tech.) I have joined my middle brother, Robert, in a venture called Carp Voice Systems. He has created a revolutionary speech recognition product, both hardware (a half board) and software for PC's. We have begun selling them, and the ready acceptance and use of the product is excellent. This is a marked contrast to the initial difficulty in teaching people how to use futures for hedging, and then have them implement hedges.

Remember, please write or fax.—**Arthur J. Carp,** Secretary, Stalco Futures, Inc., 254 West 35th St., 16th Floor, New York, NY 10001, (212) 736-1960; Fax: (212) 736-3664

77

Dear classmates, please excuse my absence from the last issue. The deadline came (and went) during my vacation week on Cape Cod. My whole family was in Massachusetts for my daughter Brielle's baptism on October 1. **Debbie Darago** and her family joined us at the christening party. Her beautiful daughters, Larissa (6) and Tatiana (3), enjoyed playing with my kids. . . . I also ran into another classmate at that epitome of fine dining in Fresh Pond, The Ground Round. **Mike Atlas,** his wife, Linda, and their son, Robert (1 1/2), were enjoying a night out. They live in Arlington, and Mike works at Northrup in Norwood. He would very much like to hear from Kappa Sig brother, **Craig Monsell,** who was last seen in Cincinnati.

Dr. **Craig Johnston** has moved from the National Institutes of Health to accept a professorship at Washington State University in the College of Pharmacy. He co-organized an international symposium on "Endocrinology—Under 35" which was held in Florence, Italy, in May 1988. He was also co-editor of the book resulting from the proceedings. . . . **Deborah Stutman-Brickey** and Michael Brickey of Bexley, Ohio are the proud parents of a large baby boy, David Harrison Brickey, born on July 23, 1988, and weighing 9½ pounds. . . . Class agent **Carol Catalano Martin** and her husband, Tom, bought a house in Lexington, Mass., and moved from their Acton townhouse last August. Carol would like to thank everyone who voted for her last spring in the alumni election for the National Selection Committee. . . . **Daniel Nolet,** at Corning Glass Works since 1979, has been appointed thermal process engineering manager in their Corporate Engineering Division.

The following snippets are taken from the notes you submitted with your *Alumni Register* questionnaires. Their length and accuracy are directly correlated with your verbosity and the clarity of your penmanship, respectively. Unfortunately, no address information was included with the sections sent to me, so I cannot always provide information as to where these classmates are now. . . . **Daniel Lee Wolk** is active in Physicians for Social Responsibility. . . . **Timothy Woldron** is very happy in his position at Sensis Corp., where he enjoys the small company atmosphere. He and his wife, Kiki, were expecting their third child in June 1988. He is continuing his interest in dance, and has broadened it to include jazz and modern as well as folk. . . . **Mark Vincent** is a scuba diver and takes flying lessons. . . . **David Tetenbaum** feels he spent too many years in graduate school.

Alberto Sadun is director of Bradley Observatory outside Atlanta, which houses a 30-inch telescope. He is in charge of its refurbishment and move into the country. It will be a state-of-the-art instrument and one of the best in the East. His hobbies include tennis and computers. . . . **James Richards,** himself a successful entrepreneur, is interested in helping others start and develop new businesses in the technology sector. . . . **Joel Lederman** recently started Lederman Engineering, providing consulting services in stress and vibration analysis and machine design.

Phuong Trinh joined a private medical practice in internal medicine and infectious diseases in November 1986. He enjoys the autonomy it offers, especially after being an employee at an HMO. He finds it both an exciting and a frustrating time to be practicing medicine, given the AIDS situation. . . . **Thomas Mills** closed his psychiatric private practice last year to take a position at San Francisco Veterans Administration Medical Center in their Post-Traumatic Stress Disorder Clinic. He remains medical director of Jail Psychiatric Services at UCSF. He is also on the clinical faculty at UCSF. His other professional in

terests include the psychiatric aspects of AIDS and gay medicine in general. Thomas and his companion, Garry Hammond (Williams '71), have lived together in San Francisco for over three years. They have an 1880 Victorian house and have recently finished some major remodeling. They have traveled extensively, having visited Australia, Rio, Buenos Aries, and in the fall Amsterdam, Vienna, Florence, and a cruise from Nice to the Canary Islands. Thomas finds being a gay man in San Francisco during the AIDS era a real rollercoaster. "On the one hand, many friends have gotten sick and died decades before they might otherwise have done so. I myself have AIDS-related complex. But there is so much comraderie and so much strength to derive from ourselves and our friends that it is reinforcing my sense of the richness of humanity."

Roland Van Liew shares an interesting perspective on his undergraduate years. "I can safely say I use little (possibly none) of the academic knowledge I received (at MIT), but I use the knowledge of language, massage, interpersonal relationships, and music I gained from IAP every day (on the job as well as off the job). The academic atmosphere, living climate, and professional attitudes were atrocious except for the Humanities Department. Judging from articles I read, they continue to be so." (Secretary's note: representatives of opposing views will be given equal space!)

Farrell Peternal, like us all, has been busy since graduation. He spent his first year in business as a junior executive at Statler Industries in Medford, Mass. Then he taught math and science at Westbridge School, a private boy's school, then in Concord. I'll let him tell the rest of the story. "In 1979 I went to Rome and studied philosophy and theology in the Roman Academic Center of the Holy Cross and reveled in history, culture, and architecture in the Eternal City for two years. Then it took two more years at the University of Navarre in Pamplona, Spain, to earn my doctorate in theology (S.T.D.). Back in the U.S. I was program director for an after-school academic program for inner-city Chicago boys at Midtown Center. On May 31, 1984, I was ordained a priest by Pope John Paul II in an impressive ceremony in St. Peter's Basilica in Rome. (It was fun returning to Rome, this time with parents and relatives.) I am now a priest for the Prelature of Opus Dei, an international Catholic organization which basically gives spiritual direction to lay persons. I give a lot of retreats, days of recollections, classes, preach a lot, hear confessions, and do a lot of one-on-one counselling of motivated people who want to learn how to lead holy lives and serve society through their work, family, and social life.

"I spent six months in Barcelona, Spain, after ordination doing every sort of priestly work, then two years in New York as chaplain of Riverside Study center, a residence for college students on the west side of Manhattan near Columbia University and Alderton house, a similar residence for college women near Hunter College on the east side. Since June 1987 I have been chaplain of Layton Study Center and Petawa Residence, both university residences and activity centers where the spiritual direction is entrusted to Opus Dei. I travel a lot to Madison, WI, to give classes and direction to students at the University of Wisconsin, to Chicago for clergy meetings, and to Valparaiso, Ind., to give retreats and theology workshops at Shellbourne Conference Center. Summers I chaplain many boys' camps, some at a rented Boy Scout camp in Lafayette, Ind., some days at Layton Study Center in Milwaukee."

I, myself, am finding life with three charming children occasionally trying, often exhilarating, always tiring, constantly wonderful. Commitments from two co-op schools, the coupon club I direct, plus MIT Educational Council duties, keep me busy when I'm not nursing, reading stories, or driving carpool. **Paul (Hertz)** is still the most supportive partner in the world as well as the most devoted father, so I survive. I'd be glad to read mail from *you!* Send it to **Ninamarie Maragioglio,** Secretary, 8459 Yellow Leaf Ct., Springfield, VA 22153

78

A 1978 class ring has been turned in to MIT Campus Police. Any member of the class who might have lost a ring on campus can call Bill Dowling or Lin Lee at the Lost and Found, (617) 253-9753 and identify their property.

Your class officers are hard at work, trying to build on the enthusiastic turnout at our reunion last June. President **Milton Roye,** vice-president **Phil Kesten,** treasurer **Diane Curtis,** and your friendly Class Secretary all met in Cambridge just prior to Thanksgiving to start putting together ideas for class activities. Milt is traveling a great deal between Detroit and Boston in his efforts to recruit MIT undergraduates for GM. He even gets to ride the corporate jet once in a while.

Phil Kesten attended our meeting after returning from Chicago the night before. Phil has been commuting between Boston and Chicago in his work at the Collider Detector at Fermilab. This facility is at the frontier of high energy physics. It is here that Phil spends his time colliding protons and anti-protons at unbelievably high speeds. Phil and his wife Kathy are expecting their first child in May and are living in Ashland, Mass. Phil tells me he attended the wedding of **Dan Amidei,** a fellow proton-smasher at Fermilab. Dan was married in October to Cathryn in Chicago.

Two more classmates who are getting involved in class activities are **Frances Scovil** and **Daniel Palka.** Frances and Dan are playing big roles in the class fundraising efforts. Our class project, the Class of 1978 Student Aid Fund, will be supporting four students this year. If contributions continue at the level of last year, we'll be able to fund one or two more students each year.

Congratulations go to **Ed Nadler** and wife Eileen who had their first child, Rachel Elizabeth, in late October. Ed also writes that he is an assistant professor in the Math Department at Wayne State University and lives in Birmingham, Mich. According to Milt, our Birmingham-based class president, Ed lives just around the corner from **Dave Loo.**

I heard from an old Interfraternity Conference cohort, **Jerry Cole,** last week. Jerry is the controller at Iron Mountain, a document storage and retrieval company in Boston. He's been involved on the buying side of the "merger mania," as his company purchased its largest competitor in the business. Jerry has been married for seven years to Wendy, his Simmons sweetheart from MIT days. The Coles have two daughters, ages 3 and 1, and are living in Walpole, Mass. Another IFC cohort, **E. Scott Golden,** has announced the opening of his own law office in Fort Lauderdale, Fla. . . . After receiving his bachelor's degree, **Anthony Patera** got his master's and Ph.D. at the 'Tute and then began teaching at MIT. It looks like Tony may be at MIT for quite a while, as he received tenure this year. He is internationally recognized for his research in fluid dynamics and heat transfer.

Mike Geselowitz and Emily Schneider sent an announcement of their daughter, Rezyl Reba, born in late October. Mike received his Ph.D. in anthropological archaeology from Harvard in 1987 and is currently an assistant curator at Harvard's Peabody Museum of Archaeology and Ethnology. He is also looking for an academic teaching position. Mike and Emily are living in Cambridge.

Ken Knaus writes from Sunnyvale, Calif., that he is an electronic design integration manager for corporate engineering at Hewlett Packard. In his spare time, he competes in triathlons and in running and biking races. He and his wife are backpackers and are involved in obedience training of their two Shetland sheepdogs.

John West finished Wharton's Executive MBA program (on weekends!) this past June. John then started his own firm, BioAutomation, in Bridgeport, Pa. John says he has "openings for employees and inventors." . . . **Steve Stein** writes us from Philadelphia: "I recently went hiking with **Mike Manes** in the Grand Tetons. We were chased down by a bull moose. Fortunately it was a few weeks short of mating season, so no harm was done. I'm back in student housing at Thomas Jefferson University for a year while my wife completes a hand surgery fellowship (her 7th year of residency). We hopefully will become real people in the real world next year!"

That's about all the news that's fit to print this column. Your secretary's efforts to make the national rowing team continue with successful physiological testing and admission to the Boston Rowing Center, the U.S. rowing development center for the Northeast. As you read this, I'll be waiting anxiously for the river Charles to thaw after a winter of rowing machines, weights, and running stairs.

Why not write and tell what you did for your winter vacation? It just takes a minute!—**Jim Bidigare,** Secretary, 659 Green St., Cambridge, MA 02139

79

I have received an appalling lack of mail lately. Maybe you're saving it all up until our 10th reunion, but why not write in the meantime to remind everybody of your existence?

Mark Schafer wrote for the first time recently to catch us up on his activities and to rectify an incorrect item that was written about him on these pages eight years ago (what a memory!). After M.I.T., Mark attended Penn State (*not* U. Penn.) to study acoustics, receiving an M.S. in that field in 1982. He did a brief stint in Seattle in the Ph.D. program in electrical engineering at University of Washington, transferring to Drexel University in 1983 and receiving his Ph.D. in biomedical engineering in June 1988. He writes, "I think I'm the only person to take two Ph.D. candidacy exams—one at U.W. in electrical engineering, and one at Drexel in biomed! My current field of interest is ultrasound (you know, looking at the babies before they're born). In 1984, I started a consulting partnership with my thesis advisor, and in 1985 we incorporated as Sonic Technologies. Our primary service is FDA-regulated testing of medical ultrasound devices. For two years, I worked full time as a senior research engineer at Interspec, a Philly-area manufacturer of cardiac ultrasound scanners, part-time on my consulting practice, and part-time on my Ph.D. Since I got my Ph.D. last June, I have been working full time as a consultant."

Back in 1987, Mark saw **Bob Hone** in San Francisco, where he is a producer for the PBS affiliate KQED and works on their science documentaries. Bob had been in the chemical industry before getting a journalism degree at Berkeley. Mark has also been in touch with Charlie Lutz, '80, who is finishing up his residency at the University of Pittsburgh's ear-nose-throat program.

Since no one else has written, I will have to write about myself. Tonight is the last performance of my run of the musical "1776," in which I play Martha Jefferson. Robert and I will be leaving shortly for Munich, where he will be attending a conference for a couple of days, then we'll play tourist for a week.—**Sharon Lowenheim,** Secretary, 500 E. 63 St., Apt. 18B, New York, NY 10021

81

It looks like this month's column will be short, as I have received only four pieces of mail. . . . **Mike Taviss** writes to say that he has resumed student status at the University of Cincinnati where he is studying law. . . . **George Carrette** founded a start-up company called MITECH, do-

ing realtime advisory control system software with fellow MIT graduate James Clancy. George claims to be progressing nicely having gotten through the beta test period and first round of financing. George and his wife are expecting their second child in February.

Good thing there is a doctor in the Woehick household. **Harvey Woehick** writes to say that he and his wife Heidi have a new son, Lars, delivered at home by Harvey. Harvey is in his fourth and final year of an anesthesiology residency in Madison, Wis. Harvey says that next time he will believe Heidi when she says she is in labor! Congratulations.

Finally, I received a press release from ASM International, a society for materials. **Lisa Parachanean Allen,** manager of materials characterization at Kopin Corp. in Taunton, Mass., was selected as the winner of the 1988 Graduate Student Paper Contest by the ASM group. Congratulations.

Well, that's it for now. I am hopeful that my mailbox will be a bit fuller next month. Please write!—**Lynn Radlauer Lubell,** Secretary, 216 Beacon St., Boston, MA 02116

82

Not much in the mailbag this month. Have you already forgotten your New Year's resolution to write your lonely class secretaries? Speaking of class secretaries, congratulations to East Coast correspondent **Linda Schaffir** for passing her architectural licensing exam. . . . **Susan Taliaferro Juncosa** and her husband Eduardo Juncosa, '83, have been busy going to weddings of fellow Burton One alums Sue Strausman, '83, who married Giorgio Rietti in August, and Doug Pennock, '83, who married Cora Favino in September. Susan also reports that Karlis Musa, '81, married Pat Anderegg last June.

Mike Colucci writes that he and his wife Teresa Colucci, '84, successfully completed their 1,800 mile bicycle trip from Seattle to Colorado Springs with only "a few wild goose chases including hopping a barbed wire fence to get on I-84 in Idaho." Back in Saginaw, Mich., doing new consumer products R&D for Dow Chemical, Mike claims that rumors that he zips Ziploc bags closed are only partially true. One thing Mike is doing is working with a program called Leadership Saginaw to introduce future leaders to all aspects of the community.

Mike's letter was written during a flight delay at O'Hare Airport and he suggests that others could use these annoying intervals to write. I don't care where you are when you write, but please drop a line soon to East Coast correspondent **Linda Schaffir** (18 Prospect Ave., Apt. B-2, Norwalk, CT 06850), West Coast correspondent **Michelle Gabriel** (656 S. Fair Oaks Ave., D-211, Sunnyvale, CA 44086) or me.—**Stephanie Pollack,** Secretary, 722 W. Roscoe St., #204, Chicago, IL 60657

83

Hi everybody. This month's appeal goes to all of you who have not sent in your news for the past two or three years. Maybe you feel that you haven't been doing anything new, so you haven't been writing. Just hearing from you would be news to the rest of us. So take a minute or two to fill us in. I've heard dozens of stories about how people who had recently written to their class secretary have won lotteries, met the woman/man of their dreams, or got that long-awaited pay raise. So try it, you may be the next one to get lucky.

We should all be proud of **Liz Bradley,** who represented us well at the Olympic games in Seoul last month. Liz rowed in the third seat of the women's four-with-coxswain boat that lost in the final heat of the summer games. Liz has also managed to compete in the world championships for the past two years. In 1986 she was a member of the United States eight-oared shell and in 1987 competed in the pairs competition. She is also stroking towards her Ph.D. in electrical engineering, having picked up her master's in 1986.

Pete Osler sent us the postcard of the month. He has just moved to Jericho, Vt., where he has taken a job with IBM. Since graduation in 1983, Pete received a master's in electrical engineering from M.I.T. in 1987 and then spent the summer with his fiancee riding bicycles from Seattle to Syracuse. Pete was married this fall and recently returned from honeymooning and hiking the Alps in Switzerland.

George Lombardo writes from Essaouira, Morocco. He is currently a U.S. Peace Corps volunteer in rural water engineering. He will be stationed in Morocco until September 1989.

I just received a letter from professional students **Randy Schweickart** and Michelle Heng, '84. Randy received his master's in mechanical engineering from Duke and is continuing at Duke for a Ph.D. in biochemical engineering. He is currently scheduled to be the first person to receive the Ph.D. degree from this new program. Michelle is in her last year of medical school at Duke, and will be going to UNC-Chapel Hill's School of Public Health for a master's next year. Michelle also included in her letter a picture of 3-year-old Ashley, who is absolutely adorable and, in conformity with everything we were told about genetics, is very blond. Michelle also notes that **Steve Yoon** will be getting married in late January in Delaware. Details at 11.

Our last source of information and gossip this month is **Hyun-A Park.** She informs us that **Michael Goldberger** and his wife, Patty, have bought a home near the Fresh Pond area. Michael is currently working for IDEA Associates, and he and Patty are expecting a child in February. . . . **Paul Nahass** is still at MIT. He has given up his tie-dye business to finish up his Ph.D. in materials science. Paul is apparently spending a good deal of time with his girlfriend, Jen Nahas (not related. . . yet). . . . **Ann Tulinsef** is also finishing her Ph.D. in Course VI. . . . Meanwhile **Charlie Swanson** is finishing his Ph.D. in economics at the University of Minnesota. . . . **Jim Schumacher** has finished medical school at Duke and is now a resident in radiology in San Diego. . . . **Melissa Miller** has finished up her M.B.A. in Barcelona, Spain, and now works for American Express in Mexico City. . . . **Dawna Levenson** is now a manager in the consulting group at Arthur Anderson. She is working and living in the Washington, D.C., area. . . . **Guillermo Chang** works with Hyun-A at the Massachusetts Division of Capital Planning and Operations. Guillermo is a systems analyst, and Hyun-A was recently promoted to deputy director.

Well, that wraps it up for this month. Keep those cards and letters coming.—**Jonathan Goldstein,** Secretary, 2 Soldiers Field Park, No. 201, Boston, MA 02163

84 5th Reunion

Dear classmates, our reunion is only a few months away! I hope that most of you are planning on attending. It should be a blast!

Rich Robbins writes that, after three great years of working at DEC, he has returned to Chicago (his home) and will begin law school at the University of Chicago this fall. The big news of 1988 concerning his ZBT pledge brothers comes in three parts: **Jack McCrae** was married last summer; **Doug MacLean** was married last fall; and **El Coleman** was married last winter. . . . **Anthony Della Fera** writes that he is currently preparing to take the first vows in the Brotherhood of St. Gregory, a community of friars in the Episcopal Church. His name in religion is Br. Ciaran Anthony, BSG. . . . **Alyssa Ann Goodman** writes that she is playing a lot of tennis and doing a lot of skiing, but she also has found the time to get two articles published in the *Astrophysical Journal* this year (with her advisor, P.C. Myers, who is also an MIT alum (Ph.D. '72) as well as a former member of MIT's faculty). She plans to graduate with a Ph.D. in June 1989.

Timothy Chambers is working to help start a Colorado Springs chapter of the MIT Enterprise Forum. Their first forum is May 25. He is playing on a city C-league soccer team sponsored by his employer. He has a few reflections on MIT. For instance, since becoming a manager, he has found fewer and fewer opportunities to practice the skills he learned in individual classes. But he does concede that MIT taught him general principles that he constantly applies. The knowledge he learned in 15.301 lab has often proven valuable. Through interactions with software engineers from other schools, he has concluded that MIT's curriculum is markedly superior!. . . . **Eric Martinot** has completely committed himself to making a difference in the world and is on staff at The Hunger Project, a worldwide non-profit organization committed to ending the persistence of hunger and starvation on our planet by the year 2000. He currently manages The Hunger Project's computer system and also the development of its participant records database that keeps track of Hunger Project participants all over the U.S.

David Horne was a local organizer for the 1987 National March on Washington for Lesbian and Gay Rights. . . . **Elaine Lee** has been a tutor with the Literacy Volunteers of Massachusetts for a year and a-half. Last June she went to China with a group of biomedical engineers under the People to People International Citizen Ambassador Program. They visited hospitals, universities, and medical device factories in Beijing, Shanghai, and Guangzhou. She was surprised to see how quickly the Chinese have caught up with the West since the Cultural Revolution, at least in some areas. The juxtaposition of modern (e.g. computed tomography) and ancient (e.g. acupuncture) was also very striking. During their 2-week stay, they also had the chance to tour the usual tourist attractions, the Great Wall being the highlight for Elaine. She also still has close ties to MIT, being a very active member of the Ballroom Dance Club.

Preston Kemp was working at ARCO Metals Co. during his leave from MIT (September 1983 to February 1984) and returned to graduate in June 1984. Then he began working in a new products development group at GTE Products Corp. in Towanda, Pa. (about 25 min. from the New York state border in Northeast Pennsylvania along the Susquehanna River). His work has primarily been applied research on developing processes to produce fine metal powders from a variety of alloys for electronics, metal injection moldings, and other diverse applications. In October 1986 he was promoted to senior engineer. His work has led to 27 U.S. patent applications, 12 of which have either been issued or allowed. He met Mary in February 1986, and they were married in July 1986. He is about to embark on a new adventure, his M.S. in materials engineering at RPI. He plans to graduate in December 1989 and return to GTE.

William Houghton graduated in June from the University of Chicago Graduate School of Business with an M.B.A. His wife, Debbie, and he are moving to Ann Arbor, Mich., where Debbie will attend grad school at the University of Michigan and he will work as a systems analyst at Ford Motor Co. Last fall they got together on Cape Cod with **Shuur Ahmed, Rich Steubi, Doug Kuller,** and Walter "Kit" Daniel, '83. Shuur is working at Draper Labs in Cambridge. Rich is a consultant in the Washington, D.C. area. Kit Daniel is teaching at the naval academy in Annapolis. Doug is working for 3M in Minneapolis. . . . **Frederick Davis** has been named a fellow of the Society of Actuaries. He is an assistant actuary with the CIGNA Corp. in Bloomfield, Conn. Actuaries use mathematical, financial, and business techniques to determine the costs of programs such as insurance, pension, and other financial security programs, as well as in management, investments, finance, marketing, and computer systems. . . . **Heidemarie**

Shefanyshyn-Piper recently completed the Engineering Duty Officer School (EDOS). During the six-week course conducted at EDOS, Mare Island, Vallejo, Calif., she received instruction in the plans, programs, policies, and procedures by which the navy accomplishes the life cycle engineering of navy ships and systems.

Robert Schoenlein received a Newport Research Award this year, one of only four new awards this year out of 77 applicants. The Newport Research Award, given to doctoral candidates working on research projects that advance laser and electro-optics technology, is funded by the Newport Corp. and co-sponsored by the Optical Society of America. Robert is studying electrical engineering at MIT in the field of femtosecond electronic processes in metals and semiconductors. . . . **Miriam Lachman** attended the wedding of **Christine Novak** last fall. . . . **Viia Valge** was also recently married. . . . **Ellen Williams** is getting married in June, and she and her fiance are planning to move to Paris, where they have both received job offers.

Keep in touch!—**Diane M. Peterson,** President, 350 Palos Verdes Blvd., Apt. 20, Redondo Beach, CA 90277-6329

85

John Karabaic says that **Margaret Hirlinger** and Scott Douglass, '84, may have had the first child with a full-blooded MIT heritage. He and his wife, Cheryl, (Crowe) lay claim to the first progeny of the class of '85. Amanda Nicole Karabaic was born on July 7, 1987. Even though Cheryl is not a "Techie," she consented to letting Amanda wear her MIT class of '20(?) booties. John is finishing up his last year in the air force. He is currently stationed at Wright-Patterson AFB. He works in the Aeronautical Systems Division's Artificial Intelligence Applications Office doing a little bit of contract management, expert systems development, and neural network hacking. He claims that the best thing about Dayton is their house—$27k for a two-bedroom, one bath. But, you do have to live in Dayton.

Mimi Yenari and **Kim Adams** expect to receive their M.D.s this June from Tulane. Last August 27 Kim married Eugene Wesley Ely at the Holy Name Church in New Orleans. A reception followed the wedding at the Omni Royal Orleans. **Sophie Lukashok** was the maid-of-honor, and Mimi was a bridesmaid. Sophie expects to receive her M.D. from SUNY, Buffalo, this June. . . . **Karen Phelan** also attended the wedding. Wes and Kim honeymooned in Hawaii and are continuing their last year of study at Tulane Medical School. Kim hopes to pursue a career in pathology and Wes a future in internal medicine.

Alex Menchaca also expects to receive his degree this June. He has been pursuing his law degree at the University of Chicago. Alex has started thinking about our reunion. The Alumni Office folks have said that it is definitely not too early to get started. First we need to form a reunion committee and come up with a t-shirt design. If you're interested in being on the committee, please contact me and lets get started!—**Stephanie Winner** (internet:winner@apple.COM), Secretary, 1026 Live Oak Dr., Santa Clara, CA 95051, (408) 985-6827

86 5th Reunion

Carl Tung wrote in from his Teradyne training class in Sunnyvale, Calif. As a field applications engineer at Teradyne (Waltham, Mass.), Carl travels around the country training customers. During his travels, he has run into some fellow classmates: **Frank Verhoorn,** Andy Chang, '87, Randall Honke, '87, and Tom Spitzuagel, '88. Frank is at HP/Cupertino designing the next generation of microprocessors. Carl has a training trip to Singapore planned, and while he is over there, he is going to visit Taiwan. . . . **Madeline Biber** began working for Kraft last August.

John Hardwick dropped me a note regarding the 100th Anniversary reunion of the Phi Gamma Delta (Fiji) fraternity to be held April 20-23, 1989. John will be attending along with **George Latas, Russell Heyda, David Anderson,** and **John Sheffield.** He also wanted to notify the following of this event: **Tinley Anderson, Ken Koblan, Nelson Yamashite, David Chonen, Tom Rebok,** and **Aaron Want.** John is still at MIT working on his Ph.D. and, aside from doing some bicycling and mountain climbing, is not doing anything real exciting.

Karen Wohl and **Ray Schmidt** came out to visit over Columbus Day weekend. Ray informed me that he, too, had been doing all the things Karen was but he was not showing up in *Tech Review.* Well, Ray, from now on you will definitely be included. Unfortunately, the weekend they came out I was on my way to San Felipe, Mexico, so our visit was very short.

The Alumni Club of Southern California sponsored a get-together at the Los Angeles AFB Officers Club, where the history of hacking at MIT was presented. **Carlos Moreno** attended as did John Davis, '87. I apologize to others of the class of '86 who attended but I didn't get their names.

Finally, I ran into **Joe Bush** and **Mark Caylor** at the Richmond Bar & Grill in El Segundo, Calif. Mike Cassidy, '87, was also there. Joe and Mike work for Hughes and, last I heard, Mark was working for a small company here in L.A. doing computational fluid dynamics.

If you're wondering why this article is so short, try writing to your secretary so she can have something to print.—**Mary E. Cox,** Secretary, SD/CLFP, P.O. Box 92960, LA AFB, CA 90009-2960

87

Here we go again. . . the latest update in the never ending saga of the Class of '87. Brace yourself. . . . **Bill Lai** writes from San Diego, Calif., where he's working for General Dynamics, Space Systems Division. On Bill's last visit to Los Angeles, he and Scott Bryant (Rockwell, L.A.) were in an accident on the L.A. freeway, "almost did a head on with a wall, and completely did a 180-degree turn." The major damages were to Bill's two-week-old car. Bill extends an invitation to all current M.I.T. students and graduates to stay with him in San Diego; advance warning in necessary.

Eriko Eda is working in Poughkeepsie, N.Y., for the buffer control element group at I.B.M. on chip design and simulation. She also teaches piano to students in the area. . . . For the year after graduation, **Molly Kiharra** worked at Belt Collins and Associates in Honolulu. The company consists of consulting civil engineers, planners, and landscape architects. She now attends Stanford working towards her M.S. in engineering management. Molly sends news about some friends in the Palo Alto area. . . . **Debbie Washington** is getting her M.S. in electrical engineering at Stanford. . . . **Marco Murgia** is working at HP in Santa Clara. . . . **Alan Meyer** is getting his M.S. in civil engineering at Stanford. . . . **Becky Thomas** and **Steve Berezuk** are also studying at Stanford.

Connie Moy adds to Molly's letter. After graduation, she traveled in the Orient for a few months. She stayed with Koh Ann Chu, '90, for a while in Hong Kong. Connie is now working for GTE in Illinois. . . . When **Linda Marinilli** (General Foods, New York) was in Chicago for a conference, **Betsy Parker** and Connie showed her around. Betsy is working at Kraft, Inc. (macaroni & cheese, Miracle Whip, etc.) in Glenview, Ill. "It's a lot of fun. Once in a while we get free food which is very helpful to a single working person like myself who hasn't quite figured out how to grocery shop and cook real meals yet." Betsy just moved to Evanston, home of Northwestern. She keeps busy by singing in a local choral group (not as challenging as the M.I.T. Choral Society, though), playing piano, and occasionally exercising.

Thanks for all the letters! I can do a much better job on this article with your help. Please, keep them coming. Until the next issue comes out, have lots of fun!—**Stephanie Levin,** Secretary, 41 Prentiss St., Cambridge, MA 02140, (617) 547-6673 (LIP-NOSE)

88

It seems I just turned in my last column, and even before that is published, I'm writing a second one. At the end of September, I attended an MIT alumni club reception in New York City and ran into many of our classmates.

Tracy (Blauvelt) Gabridge, our class vice-president, and **Pat Gabridge** were married on June 25, 1988. Tracy is presently working for Bell Labs and going to grad school at Columbia. Pat is a free-lance writer "searching for an agent." . . . **Kevin Oliveira** decided against med school (smart move!), and is a forecast analyst for Nabisco Biscuit Co. . . . **Julie Safirstein, Susan Kelly, Ellen Maker,** and **Ofer Jacobowitz** are all doing well at Mt. Sinai Medical School.

Michael Adelberg and **Andrea** are sharing an apartment on the lower west side of Manhattan. Mike is working at Videofashion, a fashion magazine produced on videocassette. He jokes that his job is to take pictures of beautiful women (Rough life, Mike!) . . . **Kris Carlson** is working at Polaroid in Waltham, Mass. She will be starting a grad program at night for a master's in hazardous material management at Tufts University. . . . **Jordan Dentz** is living in New York and working in a small architecture firm in Soho. . . . **Ken Yu** is living in Jersey City and working at Chemical Bank.

Bob Bielinski, Alan Gerstein, and **Brantley Dettmer** are sharing an apartment in Gateway Plaza in New York. Bob is working for Shearson Lehman Hutton, Alan is working for Morgan Guarantee, and Brantley is working for Arthur Anderson. The three had a party in early November. It is said that 70-hour work weeks are just a dream for Bob. . . . **Emilio Cacciavillani** and **Dante Togliatti** apparently couldn't take all the sun and fun that the University of Hawaii could offer and decided to come back to the mainland. Emilio is attending grad school at University of Pennsylvania. . . . **Young Shin** was in New York interviewing with Soloman Brothers and made an appearance at Bob's party. . . . **Marty Scheidl** is working in Connecticut for Mars Consulting Firm. . . . **Lisa Martin** says hello to all of you. . . . **Brenda Chin** and Lily Huang also attended the get-together. Both are working for Bell Labs on a Course III Coop program.

I've also received bits and pieces from various sources. **Jeff Szilagyi** is working for Amdahl in Sunnyvale, Calif. . . . **Willie Kim** is working for Cambridge Systems. Rumor has it that **Rob Aruta** is in love. . . . (any truth?).

Antoine Firmenich is enjoying grad school at Stanford University. . . . **Sarbani Bublu Thakur** is using her Mellon fellowship at the University of Toronto studying comparative literature with emphasis on feminist poetics and issues of modernity. . . . **Mavis Lee** is a full-time graduate student at MIT, focusing on relational database technology.

Navy Ensign **Cheryl Sampson** completed the Officer Indoctrination School at the Naval Education and Trainnig Center in Newport, R.I. at the end of September.

Michele Savin writes that she is in a master's program for statistics at the Wharton School at U. Penn. She got engaged to Daniel E. Levy, a chemistry Ph.D. student at MIT at the end of September. Congratulations to the both of you.

That's all the news for now. Looking forward to hearing from some of you next month!—**Grace Ma,** Secretary, 435 E. 30th St., New York, NY 10016, (212) 545-7764



COURSE NEWS

I CIVIL ENGINEERING

Frank W. Clark, S.M.'79, has been working as a consulting civil engineer since leaving MIT, and he's now begun his third year as an associate with Goldberg-Zoino. His assignment: district manager of the corporate office in Providence, R.I., with a staff of 25 working on geotechnical and environmental projects throughout New England. Clark lives in Walpole, Mass., was married last April to Stacy Pancoast of Bronxville, N.Y. . . . From Farmington Hills, Mich., **William A. Moylan,** S.M.'80, writes that he is a senior lecturer in construction engineering and last June was named director of cooperative and continuing engineering education at Lawrence Institute of Technology, Southfield, Mich. As of last October 18, Moylan and his wife Peggy are the parents of a daughter, Rebecca Mary. . . . **David Dzombak,** Ph.D.'86, has joined the academics: he's assistant professor of civil engineering at Carnegie Mellon.

Three reports on our international relations: From **Sadaaki Kuroda,** S.M.'67, in Tokyo: "Working for Japan Railway Technical Service (JARTS) as the executive vice-president. JARTS is the sole agency for international technical cooperation for Japan Railway groups. I am now providing consulting on the design and installation of slab-track for the Great Belt Link of Danish State Railways, on an integrated transport study for the Jabotabek area of Indonesia, and on a study of high-speed rail between Ankara and Istanbul, Turkey." . . . Meanwhile, **Robert S. Broughton,** S.M.'59, who's a member of Macdonald College, McGill, is working on water management for Canadian agriculture and helping with training programs for reclamation and water management in Pakistan and Egypt. . . . In Vancouver, **Salvador Miranda-Barreda,** S.M.'82, is working on computer systems for project and financial management.

At Mitre Corp., McLean, Va., systems engineer **William E. Weiss,** S.M.'80, is co-author of the National Airspace System Performance Analysis Capability Simulation Model. It simulates the 42,000 daily flights between major U.S. airports and is designed to help FAA evaluate the sources of flight delays. . . . In Boulder, Colo., **Joe Racosky,** S.M.'75, is finishing his third year of self-employment—a consultant in information and transportation systems. . . . **Edward A. Mierzejewski,** S.M.'71, is deputy director for engineering at the newly-formed Center for Urban Transportation Research, University of South Florida, Tampa. . . . **Lawrence V. Hammel,** S.M.'59, has been ordained a permanent deacon in the Roman Catholic Church in Westbury, N.Y., where he has varied ministries.

Though he's retired as chairman of the Civil Engineering Department at the University of Delaware, **Thomas W. Brockenbrough,** S.M.'46, is keeping his hand in: he's now director for District 5 of ASCE for a three-year term that ends in 1991. He's a former president of ASCE's Delaware Section as well as of the Delaware Academy of Science and the Delaware Council of Engineering Societies. . . . Another retiree (since 1963), Air Force Col. **Howard E. Webster,** S.M.'37, writes from New Windsor, N.Y., to report on his progeny: two sons are retired from the Army and Air Force and his daughter is married to a retired Navy captain. And there are 12 grandchildren and 3 great-grandchildren. . . . In Arlington, Va., near Culpeper, **Albert C. Costanza,** S.M.'56, owns and operates a 65-acre tree farm, serves as a substitute high-school physics and mathematics teacher, and is a consultant in water resources and related fields; he's also a volunteer financial counselor for the Army at Ft. Myer, Va.

In Washington, D.C., last August, **Boris M. Boguslavsky,** Sc.D.'38, wrote a short biography of the "first American" in his family, and won the grand prize in a contest sponsored by the First American Bank of Washington, D.C. "I entered the biography of my mother," writes Boguslavsky, "who was first an actress and singer in Russia and America and then, here, a university teacher." His prize is a week's trip to Russia for two that he will take next summer. Meanwhile, photographs of Boguslavsky's mother are appearing in the bank's television commercials. . . . **Roger Arndt,** Ph.D.'67, reports that he is "still professor and director, St. Anthony Falls Hyd. Lab. at the University of Minn. Travel to Norway, India, China, and Japan this year has kept my professional activities in high gear."

Lieutenant Commander **Richard S. Moore,** S.M.'64, USN (Ret.), died in San Diego on February 13, 1988, of lung cancer. He was a native of the Washington, D.C., area and a long-time resident of Alexandria, Va. Before attending MIT he had graduated from the U.S. Naval Academy, Annapolis (1961). . . . Other deaths reported include those of **Joseph F. Berberich,** S.M.'47, Newtown Square, Pa., a long-time employee at General Electric, on August 6, 1988; and **Henry D. Tomlinson,** S.M.'55, who died of cancer in Jacksonville, Fla., on June 16, 1988, after a brief illness. . . . The Alumni Association has also been informed of the death of **Wilbert M. Bjork,** S.M.'39, in 1980; details are not available.

II MECHANICAL ENGINEERING

To Professor **Stephen H. Crandall,** Ph.D.'46 (XVIII) of MIT, honorary membership in ASME awarded during the society's 1988 Winter Annual Meeting in Chicago. Crandall was cited for "seminal contributions to the understanding of random vibrations, to the education of students in dynamics and mechanics, and for service to the profession."

After a postdoctoral year at MIT, **Ziaeddin Vafa,** Ph.D.'88, has joined the General Electric Research and Development Center, Schenectady. . . . **Michael G. Hollars,** S.M.'80, finished his doctorate in aeronautics and astronautics at Stanford in June 1988; he's now working on space robotics and automation at Ford Aerospace, Palo Alto, and is also a part-time lecturer at Stanford. . . . **N. Richard Dunteman,** S.M.'70, has been transferred from LaGrange, Ill., where he was chief engineer—systems and reliability, Electro-Motive Division, General Motors, to London, Ontario, Canada. His new job for GM of Canada: manufacturing manager for locomotives in the Diesel Division. . . . After a career in high-technology electronics for Servo Corp. of America, SCM Corp., and Fairchild Industries, **Sigurd Hoyer-Ellefsen,** Sc.D.'62, is the owner of Linton Roof Truss, Inc., Delray Beach, Fla. Modern technology is necessary as buildings involve "more intricate design and manufacture," says Hoyer-Ellefsen, so he's seeking for Linton "a niche in the market as the specialist in difficult jobs." Sigurd provides technical guidance to architects and engineers as well as on-site engineering services—"the entire job process," he told *Florida Real Estate Journal*. . . . **Larry Linden,** Ph.D.'76, is now a principal at McKinsey and Co., Inc., New York. As a leader of McKinsey's Technology Management Practice, Linden has worked with McKinsey's New York clients for five years on strategy and organization issues related to technology. . . . The MAC Group in Cambridge has a new vice-president—**Michael B. Packer,** Ph.D.'80. Michael is a specialist in information technology and its impact on business strategy and organization; MAC is an international general management consulting firm.

Professor **John C. Chato,** Ph.D.'60, University of Illinois, Urbana, is back from the People's Republic of China, where he was invited to give seminars at several universities and a short course on bioheat transfer at Huazhong University of Science and Technology, Wuhan. . . . "Who are your heroes?" asked *American Scientist* magazine. The answer from Professor **David Gordon Wilson** of MIT: Leonardo da Vinci, Charles Parsons, and Ernest Rutherford. They were "giants who straddled the present and the future" and showmen as well, explained Wilson. . . . **Edgar Rose,** S.M.'48, vice-president for marine engineering and research, Outboard Marine Corp., Waukegan, Ill., is president of the American Power Boat Association for two years. The association represents more than 9,000 water sport racing enthusiasts, and Rose's firm manufactures Johnson and Evinrude outboard motors—a good match.

From Orange Village, Ohio, where he is president of Fluidesign, Inc., **Warren F. Wade,** Sc.D.'66, reports that he is district advancement chairman for the Boy Scouts of America; Wade was a scoutmaster from 1972 to 1984. . . . **John J. Martin,** S.M.'56, who is development specialist at Garrett Turbine Engine Co., Phoenix, Ariz., lists among his hobbies the restoration of a 1939 Cadillac. . . . From Alexandria, Va., **John Wlassich,** S.M.'86, a technical leader at BDM Corp., Arlington, writes, "Enjoyed a ski vacation to Aspen earlier this year with friends from work. Also enjoy biking around D.C. and on the Mount Vernon bike trail that runs along the Potomac."

The Alumni Association has learned of the deaths of **Fred D. Kochendorfer,** S.M.'49, Edgewater, Md., on September 14, 1988, and **Arthur O. Flinner,** S.M.'37, Manhattan, Kans., on May 20, 1988. Details are not available.

III MATERIALS SCIENCE AND ENGINEERING

GE Research & Development has a new director for its Metals Fabrication Facility: **Howard C.**

Fiedler, Sc.D.'53. Fiedler has been at the R&D Center in Schenectady since leaving MIT. . . . Having earned a law degree from Boston College (1986), **Ernst B. Weglein,** Mat.E.'59, is in practice with Testa, Hurwitz and Thibeault, Boston.

A notable new honor for MIT Institute Professor Emeritus **Morris Cohen,** Sc.D.'36: the National Materials Advancement Award of the Federation of Materials Societies; the presentation was in Washington late last year.

Among speakers at the opening plenary session of the World Materials Congress in Chicago last September was Professor **Merton C. Flemings,** Sc.D.'54, of MIT. He reported on the outcome of a study of materials science and engineering (in which he was a participant) mounted last year by the National Academies of Science and Engineering. . . . From the 10th Biennial Conference on National Materials Policy, held last June in Fredericksburg, Va., has come a new report on a persistent theme—"Creating a Materials Future: Translating Scientific Leadership into Commercial Advantage." Says the report, "The future belongs to those who are willing to acquire and/or develop the scientific and engineering skills required to integrate materials, manufacturing, and product design technology, *and* who can afford to invest in the facilities required to produce these excruciatingly complex systems." A principal author of the report was conference chairman **Peter R. Bridenbaugh,** Ph.D.'68, vice-president—research and development, Aluminum Co. of America.

MIT's Mining and Minerals Resources Research Institute, of which Professor **John F. Elliott,** Sc.D.'49, is director, is the lead institution in a consortium working on plasma arc technology for producing chromium. The goal is to produce ferrochromium—of which the United States now imports 90 percent of its needs—from "fine" ore that is plentiful in the U.S. but cannot be used by the conventional "submerged arc" process.

IV ARCHITECTURE

William J. Rabon, M.Arch.'56, is director of architectural design at Robert and Co., architects, engineers and planners in Atlanta. He was previously a partner in his own firm, A.M. Kinney and William J. Rabon Associates, and earlier a project designer with I.M. Pei and Associates. Rabon projects have won many honors—two national awards for the laboratory of the year, several AIA honor awards, the AIA merit award, the ASHRAE energy conservation design award, and the American Wood Council regional design award. . . . **Rodrick Leung,** M.Arch.'78, is now senior associate at Cooper Carry and Associates, Atlanta, the firm he joined in 1984. His recent projects include a downtown high-rise in Tampa, a mixed-use complex in Las Colinas, Tex., and an office complex at Pershing Point, Atlanta.

From Lincoln, Mass., **Lawrence J. Vale,** S.M.'88, reports that he is lecturing in the department at MIT this year. . . . As principal in his own firm, **Victor Caliandro,** M.Arch.'69, Brooklyn, N.Y., is busy on projects in housing, urban design, and landscaping in New York City and nearby New Jersey. . . . In Manhattan, Kans., **W. Lawrence Garvin,** M.Arch.'58, is university architect and director of the Facilities Planning Office at Kansas State University—both jobs, he writes, are "interesting and rewarding." . . . At Rosengren, Inc., **Thomas J. Rosengren,** M.Arch.'65, is busy designing, contracting, and developing buildings in Evanston, Ill., and vicinity.

This may be some sort of a record: classmates **Winston** (S.M.'35) and **Elizabeth S.** (M.Arch.'35) **Close** celebrated their 50th year of private practice in Close Associates, Inc., Minneapolis, last May, and "we're still at it," writes Winston. . . . Meanwhile, **Ernest J. Smith,** M.Arch.'47, has just retired from Smith Carter Partners, the architectural engineering firm he founded 40 years ago in Winnipeg. Smith writes that he's now studying classi-



PHOTO: © PATTE WOOD

Musician Computes the "Ultimate Instrument"

With the deceptively simple-looking electronics in the photograph, Max V. Mathews, Sc.D.'54, can turn a computer into an orchestra that responds to all the subtleties of a symphonic performance. Mathews developed "daton" at Stanford after retiring from a long career in acoustical research at Bell Labs.

If your fantasies have ever included leading your own symphony orchestra on a concert stage, meet Max V. Mathews, '52 and Sc.D.'54, research professor in Stanford's Center for Computer Research in Music and Acoustics. All you need is his new "daton," a pancake-and-pogo-stick device that can let you make a computer sound like an orchestra.

Until last year, Mathews' career was devoted chiefly to research on the acoustics of speech, with the goal of improving AT&T's telephone services. But he also made important contributions to computer music while on the staff at Bell Laboratories; after all, he explains, music and speech are closely related. "So the computer techniques I developed for research on telephones were also very interesting and useful for making music."

Last year, when he retired from Bell Labs, Mathews took his interests in computer music to Stanford. First he invented an electric violin—and now "daton."

Daton is an 18-inch-square sandwich—wires and transistors tucked between two plates, metal on the bottom and wood on top—with a joystick nearby, both sitting on a table

To "play" the daton, strike its wooden surface with a rubber hammer; the computer responds by playing a preprogrammed note or set of notes. Strike it again—the player sets the tempo—and more notes. For louder music, strike the far side of the daton; for higher notes, the right side.

Moving the joystick changes the sound—wind instruments, strings, or an entire orchestra, for example.

You can "play both the violin and the piano with one hand," says Mathews, explaining why daton is of special interest to musicians who want an accompanist for practice.

Mathews is quick to explain, of course, that his instruments are not really instruments at all. They are merely controllers—musically convenient keyboards for Mathews' real instrument, which is the computer.

"You can show mathematically that the computer can produce any sound that the human ear can hear." Indeed, says Mathews, "it has the potential for being the ultimate instrument." □

cal piano in his new retirement home on the shores of Lake Winnipeg while also doing some consulting and a few small projects with his firm.

Many winners in the news this month. **I.M. Pei,** B.Arch.'40, added to his many laurels one of the highest: the National Medal of Arts for his design of the East Wing of the National Gallery of Art, Washington; the Kennedy Library, Boston; and the new expansion of the Louvre, Paris. . . . The Pritzker Architecture Prize for 1988, the architectural equivalent of a Nobel, went to **Gordon Bunshaft,** M.Arch.'35 (shared with Brazilian architect Oscar Niemeyer). Bunshaft, retired from Skidmore, Owings and Merrill where he worked for more than 40 years, still lives in New York City; he came to prominence with the design of Lever House, New York City, and since has been responsible for several other additions to the New York skyline. . . . In a transcontinental collaboration, **Richard G. Henriquez,** M.Arch.'67, of Vancouver and **Laszlo Nemeth,** M.Arch.'67, of Toronto, have won a national competition in Canada to design an environmental sciences building for Trent University, Peterborough, Ontario. . . . For their two entries, **Peter Droege,** M.Arch.'78 and **Paul Lukez,** M.Arch.'85, both of Boston, won second-places in a national design competition called Boston Visions (195 entries) sponsored by the Boston Society of Architects. . . . To **Robert L. Ziegelman,** M.Arch.'59, the honor of fellow of the AIA; Ziegelman is president of Luckenbach-Ziegelman Partners, Inc., Birmingham, Mich. His eldest daughter, Shelly, studied architecture at the University of Pennsylvania and hopes to practice in Massachusetts.

And last but not least, there's **Leah Greenwald,** M.Arch.'78, of Cambridge, who was one of the 15 top winners ($58,802) in Jeopardy! during the 1987-88 television season. That qualified her for the "Jeopardy! Tournament of Champions" last fall. Did she win the $100,000 grand prize?

As cochairman of the Boston Architectural Center's tours committee, **Leon E. Bailey,** '58, has led 12 annual European tours for students completing BAC's architectural history course—Italy north to south, Sicily, France, Spain, and Portugal. For the students, Bailey says, the tours "have proved to be an important educational experience . . . bringing alive their feeling for space in the great buildings of the past." And they've been good for Bailey, too, he says, "increasing my photographic ability and collections of slides and city maps, my consumption of food and wine, and my feeling of being at home with the world."

V CHEMISTRY

Professors **Ronald M. Pike,** Ph.D.'53, of Merrimack College, North Andover, Mass., and **Dana W. Mayo,** '52, of Bowdoin College, Brunswick, Maine, were honored for "outstanding achievement in teaching chemistry" by the Northeastern Section of ACS early this winter. Their joint appearance to receive the James Flack Norris Award has been rehearsed in earlier years: in 1987 they jointly won the John A. Trimm Award for developing the microscale instructional program, and they're also co-recipients of the Charles A. Dana Foundation Award (1986) for teaching and the ACS Division of Chemical Health and Safety Award (1987). . . . For their achievements in catalysis research, Union Carbide's Chemicals and Plastics Group gave seven 1988 Innovation Recognition Awards to university faculty, including three members of the MIT community: Professors **Steven Buchwald** of MIT, **Terry King,** Ph.D.'79 (X) of Iowa State, and **Peter Wolczanski,** '76, of Cornell.

Walter H. Stockmayer, Ph.D.'40, Albert W. Smith Professor Emeritus at Dartmouth, opened this year's Distinguished Scientist Lecture Series at Bard College; his topic, on October 15: "Dynamics of Chain Molecules." . . . To **James S. Kaltenbronn,** Ph.D.'60, the Chairman's Distinguished Scientific Achievement Award of Warner-Lambert Co. Kaltenbronn was honored for discovering a process to synthesize a new compound, *Accupril,* for treating hypertension and congestive heart failure; he's been at Warner-Lambert, Morris Plains, N.J., since 1960.

At least 100 alumni (including former MIT postdocs) work at Merck & Co.; 65 of them are in research, most in Rahway, N.J. So it was a big gathering when Merck invited its MIT community to join 17 visitors from Cambridge for a day-long scientific reunion in chemistry and biology last November. Speakers included **Gene M. Brown,** dean of the School of Science; **Maurice S. Fox,** Wolfe Professor of Molecular Biology, MIT; **Kodzo Gbewonyo,** Sc.D.'82 (XX), biochemical engineering research fellow at Merck Sharp and Dohme Research Laboratories (MSDRL); **Edward J.J. Grabowski,** '61, director of process research, MSDRL; **T. Alan Hatton,** Class of 1922 Associate Professor in chemical engineering, MIT; **Nancy H.D. Hopkins,** professor of biology, MIT; **Gregory J. Kaczorowski,** Ph.D.'77 (VII), director of membrane biochemistry and biophysics, MSDRL; **Douglas Pettibone,** Ph.D.'88 (XX), senior research fellow in microbial pharmacometrics, MSDRL; **Robert D. Rosenberg,** Ph.D.'69 (VII), professor of medicine and biology, MIT; **Phillip A. Sharp,** MacArthur Professor of Biology, MIT; **Joanne Stubbs,** Richards Professor of Chemistry, MIT; **Gerald N. Wogan,** Underwood-Prescott Professor in chemistry, MIT; and **Mark S. Wrighton,** Keyes Professor of Chemistry, MIT. Edward M. Scolnick, president of MSDRL, said it was "the first time MIT has held a reunion in a corporate setting." The Merck Company Foundation has pledged $1 million for a new biology building at MIT, Merck's Chemical Manufacturing Division and MIT have a collaborative process-engineering program, and Merck's Research Division supports MIT research and fellowships.

Three members of the MIT faculty were speakers at a Smith Kline and French Laboratories symposium last fall on "Protein Design and the Development of New Therapeutics and Vaccines": **Klaus Biemann,** professor of chemistry; **Dagmar Ringe,** lecturer in chemistry; and **Jonathan A. King,** professor of biology. . . . The new provost of Washington University, St. Louis, is **Edward S. Macias,** Ph.D.'70. He's been on the WU faculty since leaving MIT, rising to become professor of chemistry, then chairman of the department, and later associate provost for science and technology. . . . **John Piper,** Ph.D.'60, is now vice-president—technology at Kemet Electronics Corp., Greenville, S.C. . . . **Michael C. Venuti,** Ph.D.'79, has joined the new Medicinal and Biomolecular Chemistry Department, Genentech, Inc., South San Francisco, as senior scientist. . . . A new job and title for **Elwood P. Blanchard, Jr.,** Ph.D.'59, at Du Pont: formerly executive vice-president, he's now vice-chairman.

J. Stuart Fordyce, Ph.D.'59, was at MIT last summer to lecture on space power at classes of the International Space University, and last fall he spoke on the same topic at Columbia University. As director of aerospace technology at NASA's Lewis Research Center, Cleveland, he was honored last year with the presidential award of Meritorious Executive. . . . From **Mark A. K. Patterson,** Ph.D.'82, in Scotia, N.Y.: "I'm presently in my last year at Albany Medical College, in the process of interviewing for pediatric residency programs with the goal of becoming a pediatric neurologist. Several of the programs at which I've interviewed have pointed out that I would be the only pediatric neurologist they know of with a Ph.D. in biochemistry. Thank you, MIT!" . . . **Patricia A. Mabrouk,** Ph.D.'88, is at Stanford with a two-year N.I.H. postdoctoral fellowship.

John C. Wollensak, Ph.D.'58,. is director of chemical research and applications at Ethyl Corp., Baton Rouge. He's the holder of 37 U.S. patents and when time permits enjoys woodworking, tennis, and skiing. . . . From New York City, where he is a consultant to Arthur D. Little, Inc., **Ernest R. Gilmont,** Ph.D.'56, reports that he has made "over 50 appearances as a speaker on science and public policy issues." . . . **Emory Menefee,** Ph.D.'56, has shaped his career around his commitments to peace: "My professional interests—polymer/keratin physics and chemistry—have been deliberately chosen to avoid aggressive military implications. I am passionately devoted to studies on how communication affects behavior—hence my involvement with general semantics. In other activities I enjoy writing, making music, painting, and mosaic making." . . . **Jacob A. Marinsky,** Ph.D.'49, reports that he has retired from the chemistry department at the State University of New York in Buffalo but plans to continue research.

John E. Jordan, Ph.D.'58, formerly administrative officer of the Chemistry Department at MIT, died on October 19, 1988, in Great Falls, Mont. Jordan served as research associate in physical chemistry at the Institute from 1958 to 1965, when he joined the National Bureau of Standards. But he was soon back in Cambridge to be administrative officer for about a decade before retiring in 1976. . . . Professor **Arthur W. Fairhall,** Ph.D.'52, of the University of Washington, Seattle, died on September 1, 1988; details are not available.

VI ELECTRICAL ENGINEERING AND COMPUTER SCIENCE

At the National Institute of Standards and Technology (formerly the National Bureau of Standards) **Roy Saltman,** S.M.'55, is the resident expert on computerized vote tallying, and he has "real concerns about the way votes are tallied" in U.S. elections. The critical problems, he says in a report published within months of the November 1988 presidential elections: difficulty in verifying election results, leading to the possibility of undetectable fraud, and a lack of technical knowledge by many election administrators. "These are not just computer security problems, or hardware or software problems, or management problems," says Saltman. "Voting should be looked on as a process, and the whole process, from voter registration to vote tallying, should be controlled."

To **Charles A. Zraket,** S.M.'53, president and CEO of Mitre Corp., late last year: the honorary degree doctor of engineering from Northeastern University. . . . A new assignment from his home state for **Edward E. David, Jr.,** Sc.D.'50: he is chairman of a roundtable on superconductivity to promote activities in New Jersey in this new technology. Also a member: **Stuart Schwartz,** S.M.'61 (XVI), who heads electrical engineering at Princeton. . . . To **John F. Canny,** Ph.D.'87, assistant professor of computer sciences at the University of California, Berkeley, a $500,000, five-year research fellowship from the David and Lucile Packard Foundation.

Two members of the MIT faculty were tapped to give special tutorials at professional society meetings last fall: **Richard C. Larson,** Ph.D.'69, on applications of management science to urban problems for the Institute of Management Sciences, and **Alan V. Oppenheim,** Sc.D.'64, on digital signal processing for the Acoustical Society of America. . . . And three alumni have important committee assignments for the IEEE Boston Section this year: Professor **John G. Proakis,** S.M.'61, of Northeastern University is chairman of the standing committee on fellows and awards; **David C. Crocker,** '52, of Crockergraphics, Inc., Needham Heights, Mass., chairs the chapter on professional communications; and **Robert L. Lagace,** S.M.'60, of Mitre Corp., Bedford, Mass., chairs the chapter on social implications.

What to expect if you go into business for yourself as a consultant or with a start-up company? Ask **Julian J. Bussgang,** S.M.'51, who spoke on the topic at a meeting of the Boston Section IEEE's professional activities committee late last fall. Bussgang is now a consultant, having retired as president of his own start-up firm, Signatron, Inc., a year ago. . . . **Patrick J. McCleer,** S.M.'72, is trying it: he has formed McCleer Power, Inc., in Jackson, Mich., to do R&D in power electron-

ics, power semiconductor devices, and electrical machinery. . . . **Howard D. Hillman,** S.M.'60, has opened a Boston office for his HDH Associates, which he describes as "an information systems consulting company specializing in serving small and mid-size businesses and nonprofits." A typical client is an organization "whose management information needs have grown so that a first step into computing, or an expansion of current systems, seems appropriate." . . . From Yokohama, Japan, **Yasukazu Yoshie,** E.E.'74, reports that DynaFlex, Inc., of which he's a founder, is "progressing steadily" in system integration applied to factory automation. Expansion to other Asian countries is planned.

From Huntsville, Ala., **Albert A. Mullin,** S.M.'57, reports that he is responsible for the Army's part of "star wars" (SDI) test and evaluation. . . . **Michael D. Kennedy,** S.M.'68, has joined Arthur D. Little, Inc., as a consultant in information and telecommunications. . . . **Jerome D. Abernathy,** Ph.D.'87, works at Morgan Stanley & Co., New York, in a "trading strategies group that designs trading systems and methodologies," he writes. . . . At the NASA Ames Research Center, Mountain View, Calif., **Peter J. Denning,** Ph.D.'68, has finished his fifth year as director of the Research Institute for Advanced Computer Science. And he continues as columnist ("The Science of Computing") in every issue of *American Scientist* magazine.

From Wellfleet, Mass., **David M. Horowitz,** S.M.'84, writes of a busy career: "Currently associate director of rehabilitation engineering at Tufts-New England Medical Center, Boston, working on robotics workstations and speech recognition system. Also president of Soft Talk, Inc., a small start-up company focusing on applications of speech recognition with Kurzweil AI, Waltham, Mass." Horowitz was codeveloper of VoiceRAD, a medical radiology report-generation package that uses Kurzweil technology.

In the Asbury Park, N.J., YMCA, **Edwin Z. Gabriel,** '51, is conducting a series of "Search for Truth by Youth" meetings to "help troubled, confused young people," he writes. And at his home in nearby Ocean Grove, Gabriel is busy securing and promoting patents—one covering a cable-coupling device, another an educational electronic experimentation kit—a total of some six patents in 1987 and 1988. . . . "Still active in CAD/CAM and vision systems—selling, marketing, and applications," writes **Robert Eisengrein,** S.M.'49, from Acton, Mass. He's a regular visitor to the MIT libraries, Eisengrein says, "to keep updated."

Louis Weinberg, Sc.D.'51, shares a lament from his desk at the City University of New York: "If the law on mandatory retirement—a foolish law, I believe—isn't changed this year, I will have to seek a new professorship. It seems silly to quit when one is still doing research, has Ph.D. students in three departments in which I hold a professorship (E.E., mathematics, and computer science), and is writing a book (on graph theory). Retirement might cut all this short," fears Weinberg. . . . In its first "Computer Bowl," the Computer Museum of Boston pitted high-tech luminaries of East and West Coasts against each other, fielding questions on computer history, business, folklore, and trivia. East won. No wonder: **Mitchell Kapor,** '81, chairman of ON Technology, and **John W. Poduska,** Sc.D.'62, chairman and CEO of Stellar Computer, were stars of the five-man team.

Boris T. Subbotin, Sc.D.'59, returned to MIT in 1988 for the first time in 15 years, recruiting co-op students for Hughes Aircraft, El Segundo, Calif. "Saw much change—some positive, some negative," he says, and he also saw "lots of top-caliber students." . . . From Antigua, Guatemala, **Viktor J. Pokorny,** S.M.'58, writes that, as general manager of Tele-Escuha, Guatemala City, he is "involved in financial and professional help to educational organizations in Guatemala, and also in organizing joint manufacturing with U.S. firms. We need badly to improve the educational level of the Indians, and we also need to provide education appropriate for the technician level. We have four good universities but only a few technical institutes."

Walter T. White, Sc.D.'41, Walpole, N.H., and his wife Margaret were well traveled in 1988—a cruise around Cuba and visits to James Bay (Canada), Yugoslavia, Fredericksburg, Tex. (new grandson), and Lubbock, Tex. (60th high school reunion). . . . In addition to his work in AT&T Network Operations, Bedminster, N.J., **Lynden U. Kibler,** S.M.'56, is chairman (since 1970) of the Middletown (N.J.) Township Environmental Commission, maintains his private pilot's license, is vice-chairman of the Monmouth County Water Quality Program, and uses one powerboat and two sailboats that he himself has restored.

William Calvin, '62, is a neurophysiologist at the University of Seattle and the author of two books on brain science. A third book, entitled *Conscious Machines: Seashore Speculations on Darwinian Designs,* is on the way, to be published by Bantam. Meantime, a chapter of the latter—entitled "The Trilogy of *Homo seriatum*"—is in a new book, *The Reality Club,* by author–literary agent John Brockman (Lynx Books, 1988). . . . **Howard E. Shrobe,** Ph.D.'78, of Symbolics, Inc., is the editor of *Exploring Artificial Intelligence* (Morgan Kaufmann, San Mateo, 1988), in which appear 16 survey talks from the National Conferences on Artificial Intelligence. Among the authors, in addition to Shrobe: **Daniel G. Bobrow,** Ph.D.'64 (XVIII), Xerox Palo Alto Research Center; **Kenneth Forbus,** Ph.D.'84, University of Illinois at Urbana; **Walter Hamscher,** Ph.D.'88; **Richard E. Korf,** '77, UCLA; **Ramesh Patil,** Ph.D.'82, MIT; and **Beverly Woolf,** '66 (VIII), UMass (Amherst).

The deaths of **Mark A. Princi,** '36, Marblehead, Mass., on May 14, 1988, and **John A. DiGiorgio, Jr.,** '53, Roslindale, Mass., on March 2, 1988, have been reported, but details are not available.

VI-A Internship Program

MIT's esteemed benefactor and VI-A alum **Cecil H. Green,** S.M.'24, has received yet another honor. At a celebration last November, Stanford bestowed on him its highest award—that of "Degree of Uncommon Man." **William R. Hewlett,** S.M.'36, who did his graduate work in Course VI, was a previous recipient of the same honor.

Professor **J. Francis Reintjes,** VI-A director from 1960 to 1969, attended the 25th anniversary celebration of Project MAC and its successor, the Laboratory for Computer Science, last October and reported meeting the following VI-A grads: **David L. Cohn,** Ph.D.'70, professor of electrical engineering at the University of Notre Dame; **Paul J. Santos,** S.M.'65, currently with Bolt Beranek and Newman, Inc., Cambridge; **Daniel E. Thornhill,** E.E.'65, a consultant; and **Joel M. Winett,** E.E.'65, with Analytic Sciences Corp., Reading, Mass.

On the agenda for MIT's Microsystems Research Center Fall VLSI Research Review last December were papers by two VI-A co-authors **Mathews M. Cherian,** '86, and **Satish B. Rao,** '85; both are now MIT graduate students. . . . In the Industrial Liaison Program's October *MIT Report* is an article on "Mobile and Dexterous Robots" with an accompanying photo of **Anita M. Flynn,** S.M.'85, checking a robot called "Herbert" after it had found and retrieved a soft-drink can.

Mitre Corp.'s *Mitre Matters* reports that **Steven M. Sussman,** Ph.D.'61, has been named principal engineer in the Strategic Communications Systems Group. He previously led Mitre's SDI communications team and supervised development of a network simulation for SDI space communications.

We've been privileged to see a number of alums who've paid us a visit at the VI-A Office: **Geoffrey J. Bunza,** Ph.D.'81, was at MIT recruiting for Mentor Graphics of Beaverton, Ore. Geoff has recently been named general manager of Mentor's Design and Analysis Division, and we had a pleasant reminiscence and discussion of life in the Pacific Northwest. Later I learned that **Robert H. Leong,** S.M.'84, is also at Mentor Graphics—in marketing. . . . **John R. Canfield,** S.M.'87, had just returned from working with Toshiba Corp. in Japan. He came home the long way, via China and the Soviet Union, and told me of his trip on the Trans-Siberian Railroad. . . . **Thomas H. Crystal,** Sc.D.'66, was in the area for a meeting; he's with the Institute for Defense Analysis, Princeton. . . . **Chester M. Day,** S.M.'58, was with the recruiting team for BellCore. . . . **Stephen D. Fantone,** '74, is president of Optikos Corp., here in Cambridge. . . . **Andrew M. Hawryluk,** Ph.D.'82, on campus to consult with Professor Henry I. Smith of the Microsystems Research Center, is with the Lawrence Livermore Laboratory. . . . **Steven J. Hazlerig,** S.M.'81, whom I met at the MIT Career Services Office, was here recruiting for Microsoft, Redmond, Wash., where he's a systems software engineer. . . . I met **Michael T. Howard,** S.M.'84, having lunch at Legal Seafood. . . . **Steven K. Ladd,** S.M.'81, was in the Boston area on business for the HDI Division of Raychem/Corning, where he's marketing manager. . . . **Lucene L. Tong,** S.M.'88, is pursuing further graduate study in the Harvard–MIT Health Science and Technology Program. . . . And **Daniel H. Yates,** whom I met visiting Doc Edgerton's "Strobe Alley," is a flight engineer with Delta Airlines and has applied for a co-pilot opening with them. As always, it is great to see all of you who are back our way—and good to be able to relay information on your many activities.—John A. Tucker, Special Assistant to the Department Head for VI-A and Lecturer, MIT, Room 38-473, Cambridge, MA 02139.

VII BIOLOGY

From Kibbutz Amiad, Hevel Korazin, Israel, **Thomas Berman,** Ph.D.'64, writes that he is director of the Kinneret Limnological Laboratory: "We have a group of about a dozen scientists plus 20 technicians, support staff, assorted students, and visitors engaged in basic and applied limnological research on the shores of the Biblical Sea of Galilee (Lake Kinneret). My own interests focus on understanding the role of microorganisms in this and other aquatic ecosystems."

Paul Steinberg, Ph.D.'84, assistant professor of biology at Caltech, has been named a Searle Scholar by the Chicago Community Trust and holds a $30,000 March of Dimes grant for research on gene control of cell development in embryos. . . . From Cambridge, **Sadhana Prakash,** S.M.'76, writes that she's working at the New England Medical Center, Boston, on the role of parasitic diseases in international health. . . . A new grant of $500,000 from Pfizer, Inc., has created a Pfizer Career Development Chair in the department at MIT, and Assistant Professor **Brent H. Cochran,** '78, now holds this new chair. Cochran's major research is on molecular mechanisms of cell growth regulation; he's been a teaching fellow at Harvard Medical School since receiving his Harvard Ph.D. in microbiology and molecular genetics in 1984. . . . Professor **Anthony J. Sinskey,** Sc.D.'67 (XX), was among participants in a conference on biotechnology in the Pacific Basin at the University of California, San Diego, early last fall.

VIII PHYSICS

Turkey's highest scientific honor has come to Professor **A. Nihat Berker,** '71, of MIT: the Tubitak Science Award. Berker was cited for "his important scientific contributions, at an international level, in the fields of solid-state and statistical physics." . . . **Richard J. Hawryluk,** Ph.D.'74, shared with two Princeton colleagues the 1988 Award for Excellence in Plasma Physics Research of the American Physical Society's Division of Plasma Physics. The three were cited "for the dis-

covery and scientific exploration of enhanced confinement plasmas with ion temperatures in excess of 20 keV in the Tokamak Fusion Test Reactor."

Just in time for holiday giving came MIT Institute Professor **Victor F. Weisskopf**'s new book, *The Privilege of Being a Physicist* (Freeman, 1988, $17.95). It's a collection of 16 essays written since 1972—Weisskopf's views of natural science, human creativity, and critical problems of contemporary society; it's a sequel to his earlier *Physics in the 20th Century* (MIT Press, 1972). Two months earlier Weisskopf had been honored on his 80th birthday by an international colloquium, Science, Culture and Peace, at CERN in Geneva, where he was director-general from 1961 to 1965.

Professor **K. Uno Ingard,** Ph.D.'50, of MIT is the author of *Fundamentals of Waves and Oscillations* (Cambridge University Press, 1988). . . . And *When Nations Clash: Raw Materials, Ideology, and Foreign Policy* by **Ronnie D. Lipschutz,** S.M.'78, has been published by Ballinger. It's Lipschutz' doctoral thesis from the Energy and Resources Group, University of California, Berkeley.

Margaret H. Weiler, Ph.D.'77, has moved from Raytheon's Research Division to work on HgCdTe detectors at Honeywell's Electro-Optics Division, Marlborough, Mass. . . . GE's R&D Center, Schenectady, has announced the arrival of **J. Eric Tkaczyk,** Ph.D.'88, in its superconducting materials project. . . . **Robert E. Zier,** Ph.D.'64, is now vice-president at Gershman Brickner & Bratton, Inc., Falls Church, Va., consultants in solid waste management. . . . A new assignment for **Paul D. Lazay,** Ph.D.'69: he's president and CEO of Telco Systems, Inc., Norwood, Mass.—"new and different challenges than I've previously had to deal with," he writes. . . . In Tokyo, **James F. Martin,** Ph.D.'71, is director of Rockwell International's Asia–Pacific Technology Liaison Office, where his assignment is to identify and access new technology for Rockwell. His wife Carole is covering trends in Japanese biotechnology.

After 16 years at AT&T Bell Laboratories, **Melvin Lax,** Ph.D.'47, has been Distinguished Professor of Physics at the City College of New York since 1971. . . . Rev. **William G. Guindon,** Ph.D.'48, continues to serve the chaplaincy at Smith College while living at Holy Cross; he's also assistant provincial superior on legal (canonical) matters. . . . **Sol J. Buchsbaum,** Ph.D.'57, executive vice-president of AT&T Bell Laboratories, came to the Institute late last fall with a check for $240,000—the total of six special grants from the AT&T Foundation for equipment and research in four MIT departments. . . . Having completed two three-year terms, **Stanley L. Ehrlich,** '48, has resigned as editor of IEEE's *Journal of Oceanic Engineering*. He continues as a consulting engineer at Raytheon's Submarine Signal Division, Portsmouth, R.I., and is taking committee assignments for the Oceanic Engineering Society, whose Distinguished Service Award he won in 1987.

A plaintive note from **Aaron Temkin,** Ph.D.'56, at NASA Goddard Spaceflight Center: "In 1983 my son applied for graduate study in electrical engineering at MIT and was turned down despite excellent credentials (he was, for example, admitted at Stanford). It is, of course, impossible for me to assess the competition, but I feel it is sadly amiss if some advantage in such matters is not given to the children of alumni."

Having retired from the Southern Methodist U. faculty, **Charles W. Tittle,** Ph.D.'48, is now visiting professor of nuclear engineering at North Carolina State, Raleigh. . . . Also retired: **Lyle A. Cox,** S.M.'53, formerly deputy associate director of Lawrence Livermore National Laboratory; he's now serving as a consultant and investment manager for family interests. And **Ronald G. Newburgh,** Ph.D.'59, after nearly 30 years in air force research, is now teaching physics at Worcester (Mass.) Academy: "Had a splendid first year," he writes. "Dealing with young people is good." An interesting retirement experience reported by **J. Rand McNally, Jr.,** Ph.D.'43, fusion energy consultant, Oak Ridge, Tenn.: "I met with Andrei Sakharov in Moscow in 1987 to discuss my hypothesis of a nuclear dynamo and nuclear tornado." . . . Admiral **Robert H. Wertheim,** S.M.'54 (USN Ret.), retired a second time at the end of 1987; he was senior vice-president—science and engineering for Lockheed Corp., now lives in San Diego and finds that consulting for a number of federal agencies seriously interferes with his golf game.

Ralph P. Johnson, Ph.D.'36, former corporate vice-president—science and technology and director of Ramo Wooldridge Corp. (now TRW, Inc.), died in Los Angeles on February 11, 1988; he was 78. Following MIT studies in physical electronics, Johnson's career included assignments at GE Research Laboratories, the Atomic Energy Commission, and Hughes Aircraft Co., where he was vice-president and director of R&D before joining Ramo Wooldridge. Johnson's scientific contributions were recognized by election to fellow of the American Physical Society (1941), and he was a member of the MIT Visiting Committee on Physics in the 1950s. In a memorial note in *Physics Today,* three of Johnson's colleagues recall that "he was admired and loved for his thoughtfulness, tolerance, clarity of thinking, and communication skills." . . . **Falkland M. Lansdowne,** S.M.'41, Carmel Valley, Calif., died on July 24, 1985; and **George P. McKnight,** S.M.'40, died in St. Marys, Pa., on June 28, 1988; details are not available.

X CHEMICAL ENGINEERING

To celebrate its 80th anniversary, AIChE called on Professor Emeritus **Hoyt C. Hottel,** S.M.'24, for a plenary lecture at the 1988 annual meeting in Washington. Hottel's topic, in which he reviewed highlights of his own career in relation to the history of the profession and of AIChE, was "Chemical Engineering—Exciting, Productive, Rewarding." At the other end of the age spectrum, MIT Assistant Professor **Karen Gleason,** S.M.'82, was chairman of the Young Professors' Forum at the meeting.

Michael T. Klein, Sc.D.'81, is director of the Center for Catalytic Science and Technology at the University of Delaware, where he's been on the faculty since 1981 and associate professor since 1985. The center has government and industrial grants of more than $1 million a year for studies of surface science and catalysis.

From **Gary J. Goetz,** S.M.'73, who lives in Simsbury, Conn., with wife Christine and daughter Marissa Karin (born August 23, 1988): "At Combustion Engineering I do technology planning and business development and have major responsibility for a $300 million coal gasification project proposal. Am also pursuing an M.B.A. at UConn." . . . **Matthew Croughan,** Ph.D.'88, is associate scientist in Genentech's cell culture R&D program, South San Francisco. And after hours? "Getting my rickety house and chubby body into shape."

Two organizations led by alumni have published glowing reports of their 1987-88 activities. **Lionel V. Baldwin,** S.M.'55, cites major accomplishments of the National Technological University, of which he's president: NTU's satellite network now "produces more live programs than ABC, CBS, and NBC combined," he writes. Credit and noncredit programs serve 300,000 technical professionals in the 49 corporations and 5 federal agencies with NTU affiliations, and there was a five-fold growth in revenue generated from noncredit short courses, tutorials, workships, and seminars. . . . A prospective new emphasis for AIChE's Center for Chemical Process Safety from **Thomas W. Carmody,** '46, its director: In addition to serving as an information center on process safety, CCPS plans future emphasis on research on accident prevention, safety analyses, and ways to deal with the inevitable accident when it happens. CCPS' 1988 expenses were estimated at just under $1 million.

Though recent U.S. policies have restored some of the conditions necessary for industrial innovation and expansion, says **Ralph Landau,** Sc.D.'41, in *Chemical Engineering Progress,* the future outlook is "much less clear." The largest single problem, says Landau, is business' need for "a higher degree of certainty on the economic and legal climates than we have seen over recent years." Landau is codirector of programs in technology and economic growth at both Stanford and the Kennedy School of Government, Harvard.

Henry T. Brown, S.M.'56, is manager of worldwide reagent manufacturing for Polaroid Corp., Waltham, Mass.; he's also minority affairs coordinator for the New England Section AIChE and chairman of the Board of Health in Weston, Mass. . . . From Washington, D.C., where he is a consultant operating Glenshaw, Inc., **Peter A. Glenshaw** writes, "Third world development—in all its political, economic, financial, technical, and social dimensions—has become my main focus of activity. If we can crack the nut of moving the other 80 percent of the global population to the standards we enjoy, there will be growth and development for all of us. It's comforting to see so many Tech programs pointed in this direction." . . . What does **Werner B. Glass,** Sc.D.'56, do in Westfield, N.J., where he's living after retiring from Exxon Research and Engineering Co.? Among other things, he's qualified for every final round of the U.S. Open Crossword Puzzle Championship since 1982.

Harris M. Carter, Jr., S.M.'47, a 28-year resident of Orinda, Calif., died on August 14, 1988, at the age of 67. Following WW II work with the Manhattan Project, Carter was associated with Chevron Chemical Co., San Francisco, for 37 years, and was vice-president at the time of his death.

XI URBAN STUDIES AND PLANNING

Prominent among *Ebony* magazine's "30 Leaders of the Future" late last year: **Sylvia L. Watts,** M.C.P.'83, vice-president of Taylor Properties, Inc., Boston. Said *Ebony,* "At age 30, she has established herself as a true business leader in the Boston area. In addition, she is devoting considerable time to community activities."

De Vere W. Ryckman, Sc.D.'56, is president of D. W. Ryckman & Associates, Inc., St. Louis. Ryckman says his firm "has 32 years in the environmental health engineering field and is now participating in a $400 billion market with major projects in hazardous substances and asbestos remedial action." Adds Ryckman, "We are committed to helping MIT and other universities encourage more students to pursue environmental engineering courses; the opportunities are outstanding and the need is critical." . . . In Rochester, N.Y., **Lynne A. Monaco,** M.C.P.'77, apparently provides an example: she is an attorney practicing environmental law with Nixon, Hargrave, Devans & Doyle. . . . And **Dean R. Johnson,** M.C.P.'78, is following Ryckman's advice precisely—as a student in the Tufts School of Engineering hazardous materials management program. It's a way "to focus the environmental planning I've done over the past 10 years," writes Johnson, "and it keeps me excited—and nervous at exam time."

Caren L. Mathis, M.C.P.'84, is special assistant to the commissioner of commerce and economic development in Anchorage; she's also a new mother—a daughter, Brenna Clairr O'Tierney. . . . **Linday Biggs,** Ph.D.'87, is assistant professor of history at Auburn University, Auburn, Ala. . . . A program developer for the Visiting Nurses and Hospice of San Francisco, **Norma F. Satten,** M.C.P.'45, is the co-author of a manual on developing residential settings for people with AIDS. . . . **Alan P. Sager,** Ph.D.'79, reports that he continues to enjoy teaching at Boston University's School of Public Health; his current research is on the origins and implementation of Massachusetts' new universal health insurance law.

Undercover: Police Surveillance in America (University of California Press, 1988, $25) is the provoca-

tive title of a new book by Professor **Gary T. Marx** of MIT. "If we are to remain a society with individual liberty and limits on government," he writes, "there must be greater awareness of the changing nature of privacy and emerging threats to it."

From Newport News, Va., where he is a partner in Rancorn, Wildman and Krause, **Melvin S. Krause,** M.C.P.'68, writes that he and his wife are very active in growing and exhibiting daffodils; they are currently show chairman and president, respectively, of the Tidewater Virginia Daffodil Society. "We follow the show circuit up the coast from North Carolina to Maryland and even further if the blooming season is extended.



T.F. Malone

XII EARTH, ATMOSPHERIC, AND PLANETARY SCIENCES

William C. Corea, Ph.D.'81, is now working as a geologist at Chevron Exploration and Production Services Co., Houston, specializing in the geological interpretation of well logs. . . . At the University of Minnesota, **Tibor Z. Zoltai,** Ph.D.'59, is a professor in geology and geophysics; his interests are surface structures and physical properties of minerals and mineral fragments in pollution. Among avocations: historic preservation, especially of the Historic Hill District, St. Paul. . . . Professor **Abraham H. Oort,** S.M.'63, of Princeton gave MIT's tenth annual Victor Paul Starr Memorial Lecture late last fall; his topic: "Unity and Diversity in the Climatic System."

His native state honored **Thomas F. Malone,** Sc.D.'46, last fall as a South Dakota Centennial Alumnus. Malone's distinguished career in meteorology was launched with an engineering degree from the South Dakota School of Mines and Technology in 1940; he continued as a member of the MIT faculty following his doctorate, then went on to establish the Travelers Weather Research Center, Hartford, Conn., and from there to administrative assignments at the University of Connecticut and Butler University, Indianapolis. Now a scholar in residence at St. Joseph College, West Hartford, Conn., Malone is a former president of the American Meteorological Society, the American Geophysical Union, and Sigma Xi; he also has been foreign secretary of the National Academy of Sciences and an officer of the International Council of Scientific Unions.

Ken O. Buessler, Ph.D.'86, is on the staff at Woods Hole; he spoke this fall to the Northeastern Section of the American Chemical Society on his oceanographic studies of Chernobyl radiotracers in the Black Sea. . . . Studies by **Larry A. Lebofsky,** Ph.D.'74, and colleagues at the University of Arizona show that a number of asteroids in the main asteroid belt are rich in water, but there is no spectral evidence for water in the outer asteroids. Their conclusion, reported to the American Chemical Society's 1988 fall meeting: outer-belt asteroids are made up of some of the most primitive material in the solar system, and water may have been "widely present" during the formation of asteroids. It was a decade ago that Lebofsky made the pioneering discovery that Ceres, the largest asteroid, is "mineralogically wet."

Harold E. Taylor, S.M.'62, has been teaching at Stockton State College, Pomona, N.J., since it opened in 1971; he's now been promoted to full professor in the Applied Physics Program, teaching introductory courses in physics, astronomy, and meteorology, as well as intermediate-level electronics. He spent 1986-87 on leave at Princeton's Center for Energy and Environmental Studies. . . . Having retired from the navy's Senior Executive Service last May, **Albert M. Bottoms,** S.M.'62, is now a fellow in the School of Engineering and Applied Science at George Washington University; he's also director of the Center for the Study of Industrial Competitiveness and National Security, a unit of GWU's Institute for Technology and Strategic Research—altogether a big mouthful to put on his new business card. Bottoms is also president for 1988-89 of the MIT Club of Washington. . . . Highlights of a report from **Andrew J. Wagner,** S.M.'58, Springfield, Va., who works at the National Meteorological Center, Washington: "Weather is not only my job but my hobby: I take volunteer observations in my backyard that go into the Washington area network for use in urban climate studies. Besides weather, my hobbies a: ısic and photography. Before starting on our family, my wife and I enjoyed overseas trips to Paris, Budapest, Vienna, and Israel. Our two children are adopted, one in 1986 and one in 1988—both from South America, and we journeyed to Paraguay to get them." . . . **Jack A.C. Kaiser,** '58, research physicist at the Naval Research Laboratory, Washington, is involved in optical sensing of the ocean surface and the characterization of ocean surfactant films; he was science editor for the *NRL Annual Review* in 1983, 1984, and 1985 and science consultant for 1987.

William B. Farrington, Ph.D.'53, who is self-employed at Farrington Associates, Laguna Beach, Calif., writes that he and his wife are active in local volunteer work—and he in work for professional societies, as well. . . . **Paul E. Auger,** Sc.D.'40, reports that he is retired and living in Quebec City, having taught economic geology at Laval University for 18 years, then serving as deputy minister of mines and natural resources for the province of Quebec from 1960 to 1972. . . . **Elizabeth D. Haynes,** '53, has retired after 13 years as fisheries climatologist and management officer with NOAA's National Marine Fisheries Service; her husband, a former air force pilot, is retired from the Smithsonian Institution staff, and they live in Arlington, Va.

From the *Port Townsend* (Wash.) *Leader* comes a colorful account of the horticultural achievements of retiree **Edward P. (Pete) Kaiser,** Ph.D.'41. On two city house lots, says contributing writer Jane L. Lanford, Kaiser has "100 fruit trees—not to mention roses, a vegetable garden, and lots more flowers, trees, and plants, and grass to cut." Furthermore, the fruit trees bear 55 varieties of apples, 24 kinds of pears, and "a sprinkling of plum, cherry, peach, nectarine, and apricot" varieties. And there's even a small greenhouse. Homegrown apples "make store apples taste like cardboard," Kaiser told the *Leader*'s reporter.

Colonel **Roger H. Olson,** '42 (XIV), has two requests:

1. He is organizing a reunion of the war-time meteorology class of November 1942; any members of the class not notified of the plans should write him at 1740 Sunset Blvd., Boulder, Colo., 80302.
2. He is writing a book on "rule-of-thumb" weather forecasting, and he will welcome your favorite weather saying—science-based or otherwise.

One of the candidates for Olson's reunion (above) may be **Harlan K. Saylor,**'42, who made meteorology a career after his introduction to it at MIT. Saylor retired last August as deputy director of the National Meteorological Center, Camp Springs, Md. Saylor's first civilian job after World War II was as an aviation forecaster at LaGuardia Field; he moved to NMC in 1955 to be a lead forecaster and rose through the ranks thereafter.

XIII OCEAN ENGINEERING

From Arlington, Va., **A. Paul Amesse,** N.E.'67, reports that he is director of program development at Casde Corp., a minority-owned firm involved in high-tech support of the navy and marine corps.

Captain **Walter E. Baranowski,** S.M.'39 (USN Ret.), died on September 15, 1988, in Portland, Maine. On active duty in the navy for 30 years, he served in ship production, working at yards in Norfolk, Pascagoula, Boston, and Portsmouth. Baranowski was an Annapolis graduate and a resident of Bath, Maine.

XIV ECONOMICS

Shinichi Ichimura, Ph.D.'53, writes that he is vice-president of Osaka International University; he says that he and his fellow-officers have taken on the formidable task of establishing "a truly international university" in a few years' time. . . . From the University of Lowell comes word that **Philip Moss,** Ph.D.'78, has been promoted to the tenured post of associate professor in the College of Management Science.

C. Michael Aho, Ph.D.'78, director of economioc studies and of the International Trade Project at the Council on Foreign Relations, New York, is co-author (with Marc Levinson) of *After Reagan: Confronting the Changed World Economy* (New York: Council on Foreign Relations, 1988). Senator Bill Bradley (D-N.J.), for whom Aho was economic policy adviser before joining the Council, says the book "addresses the fundamental choices the [new] president and Congress must make if we wish to accept [the opportunity] to lead a growing, interdependent global economy."

Christophe J. Riboud, Ph.D.'78, director of publicity and marketing for France Cinq, Paris, was killed in an automobile crash late in August, 1988; further details are not available.

XV MANAGEMENT

Two major awards have come to faculty in the MIT System Dynamics Program:

■ To **John D. Sterman,** Ph.D.'82, associate professor of management, the 1988 Jay W. Forrester Award of the System Dynamics Society, for important published work in the field.

■ To **Jay W. Forrester,** S.M.'45 (VI), a Lord Foundation Award for 1988 for his role in developing system dynamics. The award was given during a Lord-sponsored symposium on "The Wealth Creation Process," speakers at which included **Lester C. Thurow,** dean of the school of management; **Jordan J. Baruch,** Sc.D.'50 (VI-A), of Jordan Baruch Associates, Washington; and **George Bugliarello,** Sc.D.'59 (I), president of Polytechnic University of New York.

After working in field assignments in Cambridge and Salt Lake City, **Thomas L. Strother,** S.M.'84, has relocated to Southern California to work on air force and navy programs for Litton Guidance & Control Systems, Los Angeles; he lives in Sylmar, Calif. . . . Connecticut National Bank, Hartford, has announced the promotion of **Hans P. Bunaes,** S.M.'87, to assistant vice-president, Financial Division; he is manager of a business administration project team in the Corporate Information Resources Department. . . . From Greensboro, N.C., **Paul H. Levy,** S.M.'77, writes that he is busy with his 1986 start-up, Sterilizer Technologies Corp. His first product has been certified and is now being actively marketed to hospitals and laboratories, the product line is being expanded, and "we expect sales to exceed projections," Levy writes.

Richard H. Bernhard, S.M.'58, is spending the 1988-89 academic year as visiting professor of economics at the Norwegian Institute of Technology, Trondheim. He'll return by next fall to his post as professor of industrial engineering at North Carolina State University. . . . An easy victory for **Gregory Sullivan,** S.M.'87: he was re-elected in November to his seat in the Massachusetts House of Representatives. . . . **James E. Donaghy,**

S.M.'58, president and COO of Sheldahl, Inc., Northfield, Minn., has been elected a director of Datakey, Inc., Minneapolis. . . . **Kenneth Estridge,** S.M.'68, now has five Joy of Movement dance and fitness centers in the Boston area and one in New York City. But financial resources are limited, he told the *Boston Globe* last fall, so he's now embarking on franchising as a way to expansion.

Sloan Fellows

Ever since he wrote his Sloan School thesis on "Technological Forecasting," **Ralph C. Lenz,** S.M.'59, has built his career around that field; he's now president of Technology Futures, Inc., Austin, Texas. But he has an extraordinary hobby "to balance my interest in the future," he says—"building full-scale working replicas of historical automobiles."

Eugene J. Eckel, S.M.'62, has retired as chairman of the management board of AT&T Network Systems International B.V., Hilversum, The Netherlands; until late last fall he had been president and CEO of the firm. His successor in the latter post is **John A. Heck,** an alumnus of the MIT Program for Senior Executives (*see below*). . . . **James J. Markowsky,** S.M.'81, formerly vice-president, is now senior vice-president and chief engineer at American Electric Power Service Corp., Columbus, Ohio. . . . **William M. Zarkowsky,** S.M.'58, is executive in residence at the Georgia College Business School, Milledgville, Ga., has an active national and international consulting business, and in between times pursues three hobbies: gardening, woodworking, and stained glass work.

C.D. "Pete" Peterson, S.M.'72, is the author of *How to Leave Your Job and Buy a Business of Your Own* (McGraw-Hill, 1988), in which he sets out to prove to readers that owning their own businesses "is not mysterious, and it doesn't have to be a crapshoot." Peterson left the corporate world in 1984 after holding several senior executive positions, and he now operates a business brokerage business, C.D. Peterson Associates, Danbury, Conn.

His work as a Sloan Fellow at MIT gave **Charles C. Martin,** S.M.'58, "courage to respond to the calling," so he went back to school to prepare for the ministry; later he was a member of the "guinea pig" class for the doctor of ministry at Princeton Seminary. Now he is retired pastor of the New Castle Presbytery, Wilmington, Del.

The death of **Joseph H. Choate,** S.M.'59, of Morristown, Tenn., on July 5, 1985, has been reported to the Alumni Association; details are not available.

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Senior Executives

Samuel B. Coco, Jr., '64, formerly executive vice-president, is now president of Cabot Corp., Waltham, Mass. . . . **John A. Heck,** '81, has been advanced from vice-president and chief business officer to president and CEO at AT&T Network Systems International B.V., Hilversum, The Netherlands.

Friends of **Robert P. Cross,** '59, of La Grange, Ill., will be saddened by this report from his wife Harriet: "After a series of small strokes, Bob is no longer able to speak and is completely blind. He was proud to be associated with MIT, and the Senior Executive experience meant a great deal to him, both intellectually and at Western Electric."

Gordon H. Millar, '66, president of Motortech, Inc., Daytona Beach, has been honored by selection as an ABET Fellow, recognizing his service to the Accreditation Board for Engineering and Technology, Inc.; he was inducted during the ABET-sponsored International Forum on Engineering Education last December in Washington.

Engelbert Weber, '75, senior vice-president of Deutsche Lufthansa AG, Frankfurt, was killed in a motorcycle accident on August 5, 1988, in Bavaria; further details are not available. . . . **Hsiang Yun Chen,** '87, of Taiwan died on April 2, 1988; no further information is available.

XVI AERONAUTICS AND ASTRONAUTICS

At Jet Propulsion Laboratory, **Louis A. D'Amario,** Ph.D.'73, has a big new job: he is mission design manager for the Galileo Project to Jupiter, the launch of which is set for October 1989. . . . **Warren H. Dalley,** S.M.'84, is at Rocketdyne Division, Rockwell International, Canoga Park, Calif.; his assignment: systems manager at the Electric Power Systems Simulation Laboratory preparing for Space Station Freedom. . . . From Alexandria, Va., **Steven R. Maimon,** S.M.'65, sends us a prospectus for the Hunter Group, Inc., of which he is founder (1977), chairman, and CEO: Hunter is a "global training company providing a full spectrum of trade and related services in business, technology commercialization, and financial services. Specialties include strategic resources, consumable/disposable products and commodities, and related technologies and operations." . . . *Introduction to Control System Analysis and Design* (Prentice-Hall) by **Francis J. Hale,** Sc.D.'63, is now in its second edition; Hale is professor of mechanical and aerospace engineering at North Carolina State University.

From Cambridge, **Kirk Goodall,** S.M.'87, wrote late last year, "For the past year I have been working as a computer consultant while continuing work that began with my master's thesis on dynamic character recognition. I'm presently engaged with research into neural networks and expect to be moving to the San Francisco Bay area shortly." . . . Despite his job as vice-president for sales and marketing at the William Tell Inn, La Grange, Ill., **Vlado Lenoch,** S.M.'76, hasn't turned his back on aeronautics: his new hobby is restoring and demonstrating P-51 Mustang aircraft. . . . Since he retired from the navy with the rank of captain in 1969, **Henry F. Lloyd,** S.M.'46, has been a member of the administration at Flagler College in St. Augustine, Fla.; he's now registrar, and has "no plans for retirement," he writes. . . . **Kenneth M. Tebo,** S.M.'47, has had a similar career; retiring from the navy, he joined George Washington University. But last year Tebo retired as director of continuing engineering education at GWU, and he's now doing volunteer work with the Red Cross and navy relief in the Falls Church, Va., area.

Wesley A. Kuhrt, S.M.'40, of Simsbury, Conn., who was retired after a career that included service as president of Sikorsky Aircraft and senior vice-president—technology at United Technologies, died in an automobile accident on October 20, 1988, in Bloomfield, Conn., at the age of 70. For eight years before retiring in 1982, Kuhrt was responsible for UTC's technology development, and he was honored in 1984 when UTC gave his name to its new optics facility in West Palm Beach, Fla. Joining Pratt & Whitney Aircraft Division in 1939, Kuhrt transferred to the UT Research Center in 1941, became director of research in 1964, and from 1967 to 1974 was executive vice-president and later president of Sikorsky.

Robert M. Edholm, S.M.'45, a retired (1984) test pilot, died in Fort Worth, Tex., on September 2, 1988; he was 71. After World War II service with the Army Air Corps Flight Test Division, Dayton, and Edwards Air Force Base, Edholm was chief test pilot for McDonnell Aircraft Co., St. Louis, and later for Bell Helicopter/Textron.

The deaths of three alumni have been reported, with few details available: **Howard A. Magrath,** S.M.'38, of Bellbrook, Ohio, retired from Wright-Patterson AFB, on April 5, 1988; **Arnold F. Kossar,** A.E.'51, of Fairlawn, N.J., vice-president of Curtiss-Wright Aeronautical, Wood-Ridge, N.J., on July 1, 1988; and **Lonnie C. Von Renner,** S.M.'70, of Lincoln Park, Mich., on June 12, 1988.

XVII POLITICAL SCIENCE

Professor **Suzanne Berger,** a specialist in Western European politics and political economy who's been at MIT since 1968, became head of the department effective January 15; she succeeds Professor **Donald L.M. Blackmer,** head since 1982. Berger studied at the University of Chicago (B.A. 1960) and Harvard (Ph.D. 1966), is the author of books on modern French political history, and the co-author (with MIT Professor **Michael J. Piore)** of *Dualism and Discontinuity in Industrial Societies.* She was founder and remains director of the Seminar on Foreign Politics and the National Interest, a year-long MIT program taught in Washington, D.C., for senior members of the national security community.

A "sudden mid-career redirection into academic administration," says **Michael A. Brintnall,** Ph.D.'77: he's now vice-president for academic affairs at Mount Vernon College, Washington, D.C. . . . **Brian M. Pollins,** Ph.D.'81, is now associate professor with tenure at Ohio State; he's also incoming president of the International Studies Association/Midwest and the author of articles forthcoming in *American Journal of Political Science* and *American Political Science Review.* . . . In St. Louis, **Edward R. Jayne II,** Ph.D.'69, is vice-president of program development at McDonnell Douglas Astronautics Co. . . . **Donald E. Dickson, Jr.,** Ph.D.'75, is doing policy research, program evaluation, and legislative drafting for the Vermont Legislature—and also managing the legislature's computer system. . . . And **Stuart A. Ross,** S.M.'67, reports from California State University, Fullerton, that he is director of the Office of Faculty Research and Development.

Professor **Harvey M. Sapolsky** is the editor of the *Proceedings,* now in print, of the MIT Symposium on World Telecommunications Policy (Cambridge, January 27-28, 1988), convened to commemorate the contributions of the late Professor **Ithiel de Sola Pool.** Among the contributors: Professors **Jerry A. Hausman,** MIT; **W. Russell Neuman,** MIT; **Daniel Roos,** Ph.D.'66 (I), MIT; **Richard Schmalensee,** Ph.D.'70 (XIV), MIT; **Marvin Sirbu,** Sc.D.'73 (VI), Carnegie Mellon; **Eugene B. Skolnikoff,** Ph.D.'65; **Peter Temin,** Ph.D.'64 (XIV), MIT; **Lester C. Thurow,** MIT; and **John Zysman,** Ph.D.'74, University of California, Berkeley. Copies are available from the department.

XVIII MATHEMATICS

To **Eric Reissner,** Ph.D.'38, professor emeritus of applied mechanics, University of California at San Diego, the ASME Medal, highest award of the American Society of Mechanical Engineers. Reissner was cited for "eminently distinguished engineering achievement . . . through research on plates and shells, structure, theory of elasticity, turbulence, aerodynamics, wing theory and mathematics, and for his stewardship of numerous doctoral candidates." Reissner was a member of the mathematics faculty at MIT until going to California in 1970; he retired in 1978.

John W. Carr, Ph.D.'51, who's a member of the Bryn Mawr faculty, must be a near-stranger at home. This year he's on sabbatical at the University of Montpellier, France. In 1986-87 he served as visiting distinguished professor and acting chairman of computer science at the University of South Florida, Tampa, and in 1987 he was in Cairo as chairman of the Computer Science Department at the Egyptian Air Force Academy. . . . **Deborah Franzblau,** Ph.D.'85, is assistant professor of mathematics at Vassar.

A travel tip for south-bound alumni from **Jan List Boal,** Ph.D.'59: "My wife Bobby and I are owners and operators of The Veranda, a bed-and-breakfast inn in Senoia, Ga., 30 miles south of the Atlanta airport. I'm still teaching full-time at Georgia State, so the schedule is full."

XX APPLIED BIOLOGICAL SCIENCES

A major new honor for Institute Professor **Nevin S. Scrimshaw** of MIT: the $50,000 Bristol-Myers Award for Distinguished Achievement in Nutrition Research. Scrimshaw was chosen for pioneering the concept of "the synergism between malnutrition and infection and as the developer of the first successful low-cost vegetable weaning formula for infants."

Advice to MIT from **Oscar P. Snyder,** S.M.'59: "You really need to restart the foods program." Snyder is president of the Hospitality Institute, St. Paul, and he writes that, "because of my education at MIT, I am now the national leader in technology and management for eliminating foodborne illness in retail food operations in America. . . . There is a great opportunity to integrate expert systems and food science and technology to reduce the cost of feeding the world."

Laura C. Green, Ph.D.'81, is co-author (with John D. Graham and Marc J. Roberts of Harvard) of *In Search of Safety: Chemicals and Cancer Risk* (Harvard University Press, 1988). Green is vice-president—environmental health and toxicology, Meta Systems, Inc., Cambridge. According to its publisher, the book "squarely addresses the complex interaction of science and regulatory policy."

XXI HUMANITIES

Professor **Loren Graham** was well-traveled last fall—in the Soviet Union in October negotiating for a Russian translation of his book *Science, Philosophy and Human Behavior in the Soviet Union* and in Hawaii in November to give two papers at the annual convention of the American Association for the Advancement of Slavic Studies. . . . Professor **Isabelle de Courtivron** has been elected to the board of the Massachusetts Foundation for Humanities and Public Policy, which makes grants for projects relating the humanities to social and public policy issues.

To Professor **Catherine V. Chvany,** a medal for outstanding scholarly contributions to Russian studies at the Tenth Congress of Slavists in Bulgaria last September, and to Professor **Claire J. Kramsch,** the Nelson Brooks Award for outstanding research in the teaching of language and culture from the American Council of Teachers of Foreign Languages. . . . Recent lectures by Professor **Leo Marx:** "The American Ideal of Space" for a fall symposium of the Museum of Modern Art, New York; "Is Liberal Knowledge Worth Having?" at a conference of the Association of Graduate Liberal Studies; and the inaugural lecture for the new Commonwealth Center for the Study of American Culture, the College of William and Mary. . . . Professor **Kenneth Keniston,** director of STS, spent a month last summer at the Center for Advanced Studies in the Social Sciences in Madrid, where he gave a seminar on "Non-Marxist Criticism of Industrial Society."

XXII NUCLEAR ENGINEERING

Craig A. Chambers, S.M.'75, is director of operations of the Space Center at Adams-Russell Electronics, Waltham, Mass., producing high-reliability microelectronic components for satellites and military aircraft. . . . After many years in General Electric's breeder reactor programs, **Charles L. Larson,** Sc.D.'59, is now working in reliability engineering for BWRs at GE Nuclear Energy, San Jose. . . . Captain **Mario P. Fiori,** USN, Ph.D.'69, is commander of the Naval Underwater Systems Center, Newport, R.I. . . . From Zurich, **George Yadigaroglu,** Sc.D.'70, reports that he is heading the thermal-hydraulics laboratory of the Paul-Scherrer Institute, the newly reorganized Swiss national research center. He continues as a member of the faculty in nuclear engineering at the Swiss Federal Institute of Technology, Zurich. . . . **James K. Liming,,** S.M.'83, who lives in Fountain Valley, Calif., continues as a management consultant with Pickard, Lowe and Garrick, Inc., Newport Beach. His work includes safety-related and economic risk analyses for the electric, petrochemical, aerospace, and defense industries in the U.S. and abroad.

XXIV LINGUISTICS AND PHILOSOPHY

Jean-Roger Vergnaud, Ph.D.'74, has moved from the East to the West Coast: he is now Andrew W. Mellon Professor in the Department of Linguistics, University of Southern California. As a member of the University of Maryland faculty and the Centre National de Recherches Scientifiques, Paris, Vergnaud is credited with "major and far-reaching contributions to the theory of generative grammar."

TPP TECHNOLOGY AND POLICY PROGRAM

David Dorau, S.M.'87, reports several changes in his life: a new job at Black and Veatch, Kansas City, in solid waste manaagement, a new house, and a new son. Congratulations! . . . **Eric Maille,** S.M.'84, is now director of economic analyses at Hydro Quebec, Montreal. . . . **Jonathan Weiss,** S.M.'78, who's been host for two previous TPP Washington reunions, has joined a small computer software house, Desk Top Financial Solutions, where he's doing systems analysis and helping manage projects. The firm specializes in customized government budgeting systems. . . . **Olivier de Botton,** S.M.'88, is working in management consulting in Peat Marwick's Paris office.

From the Johns Hopkins Applied Physics Laboratory, Silver Spring, Md., **James Spall,** S.M.'81, reports that he was chairman for the 1988 Atlantic Regional Probability and Statistics meeting. He's also the author of a recent book—title not specified—published by Marcel Dekker, Inc. We also hear that the annual APL golf championship has been added to his trophy room. . . . **Elizabeth Mulcahy Chehayl,** S.M.'79, has moved from Cleveland to Barrington, Ill., where she's taking time off to supervise restoration of their 90-year-old Victorian house and help son Daniel's transition to first grade. Her husband is employed by Firestone, and Chehayl reports that they are "boning up on Japanese customs and wondering whether we'll soon be located in Tokyo, since Firestone's new owners are Japanese." . . . **Tatsujiro Suzuki,** S.M.'79, continues as a visiting scientist at the MIT Energy Laboratory, now working with Professor **Kent F. Hansen,** Sc.D.'59 (XXII) on an international program for enhanced nuclear power plant safety.

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From Yokohama, **Masao Ishihama,** '83, writes that he is working in the field of noise and vibration in motor vehicles. And, he says, "as the eldest MIT alumnus at Nissan Motor Co., Inc.," he's been trying to sell the management on sending more students to CAES. . . . **Duane W. Roland, Jr.,** is now director of project management at Eastman Kodak Co., Rochester.

The death in December 1986 of Lieutenant Colonel **Chester F. Jatczak,** '66 (USAF Ret.), in Canton, Ohio, has been reported. Jatczak, who retired from active duty in 1965, was a research scientist at TMK Co., Canton, at the time of his death; further details are not available.

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James Sloss, 1910-1988

James Sloss, who retired in 1982 as senior lecturer in the Center for Transportation Studies, died in Newton, Mass., on November 5 after a long illness; he was 78.

Sloss was a major contributor to MIT's transportation program for the decade prior to his retirement, teaching a number of subjects and conducting research on such topics as railroads in developing countries, rail merger analysis, operations planning, and rail rationalization. He had held various posts in the transportation field before joining MIT. □

Robert B. Semple, 1910-1988

A life member emeritus of the Corporation, Robert B. Semple, '32, died in Grosse Pointe Farms, Mich., on November 4; he was 78.

The former president of Wyandotte Chemicals Corp. and chairman of BASF Wyandotte Corp., Semple was first elected to the Corporation in 1961 and accepted life membership in 1967. He had been a major participant in MIT fund-raising for the Detroit area, which led to his receiving the Alumni Association's Bronze Beaver in 1965. An accomplished clarinetist, he was also president and chairman of the Board of Directors of the Detroit Symphony Orchestra for many years.

After studying for two degrees in chemical engineering at MIT, Semple worked for Monsanto Chemical Co. from 1933 until he became president of Wyandotte in 1949. □

C. George Dandrow, 1899-1988

C George Dandrow, '22, who was a member of the MIT Corporation for from 1947 to 1952 and president of the Alumni Association for 1948-49, died in Jacksonville Beach, Fla., on August 9; he was 89.

Dandrow retired from Johns-Manville Sales Corp. in 1964 as vice-president and general sales manager after a 42-year career in the building field; his MIT degree was in the course in General Engineering.

To recognize his long-time dedication to the Institute, Dandrow was given the Alumni Association's Bronze Beaver in 1982. In addition to his service on the Corporation, Dandrow had been president of the MIT Club of New York for five years and was active in fund-raising and other alumni relations programs. □

Stanley C. Dunning, 1894-1988

Stanley C. Dunning, '17, whose Bronze Beaver award citation (1975) paid tribute to "a constant, effective and loyal contributor to the advancement of MIT," died in Concord, N.H., on September 11; he was 94.

Dunning was a long-time class agent, and he became secretary of his class in 1973 and president in 1977.

As a first lieutenant in the Field Artillery, Dunning saw action in France in World War I and then served in the army of occupation. Later he had a long career in manufacturing and sales for Wesco Chemical Co., Montreal, living in New Jersey, New York, and Montreal before moving to Cambridge upon retirement. □

Russell W. Ambach, 1901-1988

Russell W. Ambach, '24, secretary of his class since 1970, died in Wakefield, R.I., on October 30; he was 87.

Ambach studied civil engineering at MIT, and his engineering career took him to Alabama, Pennsylvania, Illinois, and Missouri before he joined the Atlantic Refining Co. in Providence in 1935. He retired in 1966 to live in Brookline, Mass., for a number of years before returning to Rhode Island. □

Donald G. Morse, 1900-1988

Donald G. Morse, '21, a leader of Class of 1921 activities during the past 15 years, died on September 24 in St. Elizabeth's Hospital, Brighton, Mass.; he was 88.

Morse was a long-time resident of Wellesley Hills, Mass., and was associated with a family business, the James F. Morse Rendering Co. of Boston, for more than 40 years. He studied chemical engineering at MIT.

Morse was a member of the first MIT varsity crew in 1920, and he maintained an active interest in rowing and in the Friends of MIT Crew. He was a long-time member of the Alumni Council and beginning in 1976 was chairman of the Class of 1921's reunions. □

Deceased

The following deaths have been reported to the Alumni Association since the *Review*'s last deadline:

Mrs. William R. Glidden, '12; February 12, 1981; Geneva, Ill.

Herbert G. Shaw, '13; July 23, 1988; Wallingford, Conn.
Charles J. McCarthy, '16; October 13, 1988; Greenwich, Conn.
J. Douglas Robertson, '16; October 31, 1988; Taunton, Mass.
Stanley C. Dunning, '17; September 11, 1988; Concord, N.H.
Al F. O'Donnell, '18; May 18, 1988; San Diego, Calif.
Carleton E. Alexander, '20; March 13, 1986; Wickliffe, Ohio.
Robertson Ward, '20; August 24, 1988; London, England.
John H. Driggs, '21; April 17, 1987; San Mateo, Calif.
Philip R. Payson, '21; January 15, 1987; N. Fort Myers, Fla.
Mrs. Paul H. Rutherford, '21; May 4, 1988; Danvers, Mass.
George E. Shoemaker, '21; September 15, 1988.
Whitney H. Wetherell, '21; October 29, 1988; North Chatham, Mass.
C. Hall Baker, '22; October 13, 1988; Cape Elizabeth, Maine.
Chang Tsu Chien, '22; August 7, 1988; Taipei, Taiwan, China.
Everett M. Strong, '22; September 23, 1988; El Toro, Calif.
Stanley S. Setchell, '23; August 1988; Lynn, Mass.
Russell W. Ambach, '24; October 30, 1988; S. Kingstown, R.I.
Leigh E. Fogg, '24; October 21, 1988; Gorham, N.H.
P(urinton) Fay Marrs, '24; July 17, 1988; Glens Falls, N.Y.
Paul L. Miller, '24; October 16, 1988; Silver Spring, Md.
Daniel J. Bloomberg, '26; August 14, 1984; Santa Barbara, Calif.
Robert R. Ellis, '26; August 24, 1988; Asheville, N.C.
Leonard L.F. Remington, '26; October 9, 1988; Franklin, Mass.
Louis L. Brega, '27; December 26, 1987; Poughkeepsie, N.Y.
Edward O.F. Jones, '27; July 4, 1988; Wheaton, Ill.
Herbert P. Dayton, '28; July 31, 1988; Channelview, Tex.
Lycurgus Laskaris, '28; March 5, 1988; Dubuque, Iowa.
Mieth Maeser, '28; July 12, 1988; Roselle, N.J.
Frank G. Webster, '28; October 10, 1988; Holderness, N.H.
Ira H. Abbott, '29; November 3, 1988; Newport News, Va.
Seymour A. Baum, '29; August 5, 1988; Jupiter, Fla.
Mabel C. Merritt, '29; October 10, 1988; Dedham, Mass.
Thomas H. Speller, '29; August 3, 1988; Buffalo, N.Y.
Curtiss S. McCune, '30; December 1987; Wilmington, Del.
G(eorge) Franklin Temple, '30; August 25, 1988; Berwyn, Penn.
Richard S. Whitehead, '30; August 25, 1988; Santa Barbara, Calif.
Benjamin Yoffe, '30; February 24, 1988; Las Vegas, Nev.
William S. Clark, '32; June 22, 1988; Columbus, Ohio.
Jay H. Forrester, '32; September 5, 1988; Boca Raton, Fla.
Robert E. Moore, '32; May 25, 1988; Reading, Penn.
Max Richmond, '32; September 29, 1988; Peabody, Mass.
Robert B. Semple, '32; November 4, 1988; Delaphane, Va.
Charles M. Thayer, '32; April 22, 1988; Columbus, Ohio.
Allan A. Hinkle, '33; September 25, 1988; Signal Mountain, Tenn.
Samuel S. Saslaw, '33; September 2, 1988; September 2, 1988; Jacksonville, Fla.
Kenneth A. Sawin, '33; October 26, 1988; Wellesley, Mass.
Loren H. Hutchins, Jr., '34; April 17, 1988; Portsmouth, N.H.
Gillette K. Martin, '34; April 12, 1988; Pensacola, Fla.
John Streng, '34; July 29, 1988; Fort Lauderdale, Fla.
Wesley A. Kuhrt, '39; October 19, 1988; West Simsbury, Conn.
George McKnight, '40; June 28, 1988; St. Marys, Penn.
Falkland M. Lansdowne, '41; July 24, 1985; Carmel Valley, Calif.
Robert D. Taylor, '41; October 31, 1988; Boxborough, Mass.
George A. Granitsas, '42; October 14, 1988; Delray Beach, Fla.
Robert M. Edholm, '45; September 2, 1988; Fort Worth, Tex.
Joseph F. Berberich, '47; August 6, 1988; Newtown Square, Penn.
Harris M. Carter, Jr., '47; August 14, 1988; Orinda, Calif.
Charles H. Meers, '48; April 8, 1988; Dallas, Tex.
Robert L. Springmeyer, '48; July 4, 1988; Salt Lake City, Utah.
Sydney G. Tilden, Jr., '48; May 4, 1988; Glen Head, N.Y.
Theodore R. Yoos, Jr., '48; October 27, 1988; Lexington, Mass.
Thomas E. Dillon, '50; October 15, 1988; Ogunquit, Maine.
Robert J. Kadel, '50; April 23, 1988; New York, N.Y.
Arnold F. Kossar, '51; July 1, 1988; Fairlawn, N.J.
Richardson M. Courtney, '52; June 19, 1988; Sarasota, Fla.
Carl Frederick Kaare Jensen, '52; January 1988; Eiksmarka, Norway.
John E. Jordan, '52; October 19, 1988; Great Falls, Mont.
John A. DiGiorgio, Jr., '53; March 2, 1988; Roslindale, Mass.
Daniel D. Rothenberger, Jr., '55; February 13, 1987; Marlborough, Mass.
Michael O. Hopper, '57; June 15, 1988; Shrewsbury, Mass.
Joseph H. Choate, '59; July 5, 1985; Morristown, Tenn.
Mark A. Swift, Jr., '69; July 28, 1988; Oakland, Calif.
Lonnie C. Von Renner, '70; June 12, 1988; Lincoln Park, Mich.
Christos V. Demetriou, '73; June 19, 1988; Nicosia, Cyprus.
Paul H. Kalikstein, '74; March 10, 1988; White Plains, N.Y.
Engelbert Weber, '75; August 5, 1988.
Don M. Johnstone, '77; April 1988; New York, N.Y.
Daniel F. Lieberman, '78; October 1988; Nanuet, N.Y.

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ALLAN J. GOTTLIEB

Celebrating Winter With A Dogsled-Theoretic

Alan Katzenstein adds to our palindrome collection one attributed to Penelope Gilliatt in an article in *Time* magazine:
Doc, note. I dissent. A fast never prevents a fatness. I diet on cod.
and encourages palindrome fans to read "A palindromic dialogue by J.A. Lindon," which can be found in Martin Gardner's "Mathematical Games" column in *Scientific American* sometime in the early 1970s. Mr. Katzenstein kindly sent a photocopy, which I will reproduce upon request.

Ric Klass reports that a Harvard Business School classmate, Masonn Sexton, established a company called Harmonic Research that uses the Fibonacci series to aid in stock forecasting.

Finally, Meredith Warshaw has requested that "some of [our] fictitious computer experts and IEEE members be labeled 'she' instead of 'he'." Since I agree with Ms. Warshaw but prefer not to impose my will on others' words, I ask that proposers try to be evenhanded in their choice of pronouns.

Problems

F/M 1. We begin with a bridge problem from Doug Van Patter:

North
♠ A K 5
♥ Q 4 3
♦ 7 5 4 2
♣ 8 6 5

South
♠ 7
♥ A K 10 8 6 2
♦ A K 3
♣ A 7 4

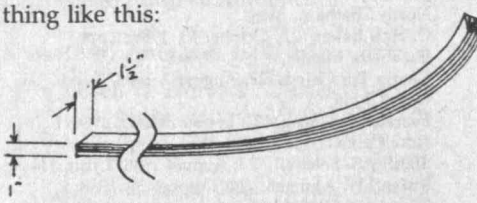
Over-optimistic bidding has led to an unlikely six-heart contract. West leads the ♣K, which you take with the ♣A. When you cash the ♥A and ♥K, West shows out on the second round, leaving East with the ♥J. How do you proceed? If you were in a four-heart contract (duplicate bridge), what line of play would you adopt?



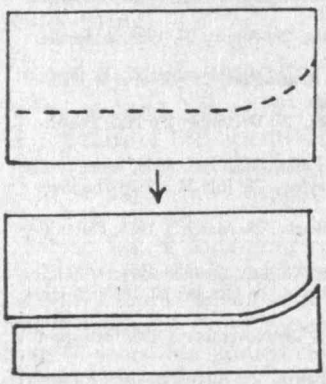
SEND PROBLEMS, SOLUTIONS, AND COMMENTS TO ALLAN J. GOTTLIEB, '67, THE COURANT INSTITUTE, NEW YORK UNIVERSITY, 251 MERCER ST., NEW YORK, N.Y. 10012.

F/M 2. Nob. Yoshigarhara sent us a problem from Y. Kotani:
For each positive integer n, consider writing the integers from 1 to n inclusive and let $f(n)$ be the number of times the digit 1 was used. For example $f(3) = 1$, $f(10) = 2$, and $f(12) = 5$. Clearly $f(1) = 1$; what is the smallest $n > 1$ with $f(n) = n$?

F/M 3. Clifford Cantor, from Anchorage, Alaska, asks our first-ever dogsled-theoretic problem:
My brother Jim is laminating together four thin layers of hickory to make a new runner for his dogsled. Each piece is 0.25″ thick, 1.5″ wide, and about 8′ long. The four pieces will be laminated to form a 1″ thick runner that will look something like this:



He wants to make a two-piece mold for gluing the strips together. He plans to cut an 8′ sheet of plywood 1.5″ thick, so the cut edges will be the surfaces of the mold.



He called me to ask whether he can produce both pieces with a single saw cut. I told him he could not. Was I right? If not, what curve would have the requisite properties?

F/M 4. Charles Piper takes us from dogsled runners to the human variety with a problem he believes dates back to a circa 1850 book, *Exercises in Algebra*, by Jones:
A offers to run three laps while *B* does two but gets only 100 yards into his third

lap when *B* wins. He then offers to run four laps to *B*'s three, and quickens his pace in the ratio of 4:3. *B* also speeds up, in the ratio of 9:8, but in the second lap falls off to his original pace, and in the third goes only 9 yards for the 10 he went in the first race. *A* wins the race by 180 yards. How long is each lap?

F/M 5. Albert Mullin poses the following: By analogy with palindrome, a validrome is a sentence, formula, relation or verse that remains valid whether read forward or backward. For example, relative to (prime) factorization, 341 is a factorably validromic number, since 341 = 11·31, and when read backwards gives 13·11 = 143, which is also correct. What is the largest factorably validromic number you can find? Remember that 1 is not prime so $n = n \cdot 1$ is not valid.

Speed Department

SD 1. Jim Landau has a boxed set of books containing two volumes each containing 512 pages not counting the covers. A bookworm starts at volume I page 1 and chews his way through to volume II page 512. How many pages has he eaten through (not counting the covers)?

SD 2. Mr. Landau also wants to know how many successful parachute jumps must a paratrooper make before he can graduate from jump school?

Solutions

OCT 1. Given these hands, and the bidding shown, West leads the ♠10, and East encourages with the ♠7. How do you play this hand?

North
♠ 4 3
♥ K 7 6
♦ A Q J 5 2
♣ K Q 5

South
♠ K 6
♥ J 10 8 5 3 2
♦ K 7
♣ A 6 4

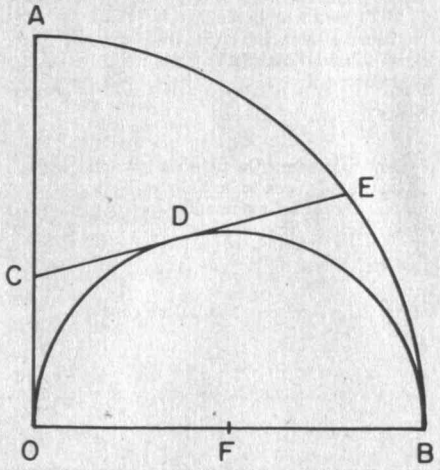
Bidding

N	E	S	W
1D	1S	2H	Pass
3H	Pass	4H	Pass
Pass	Pass		

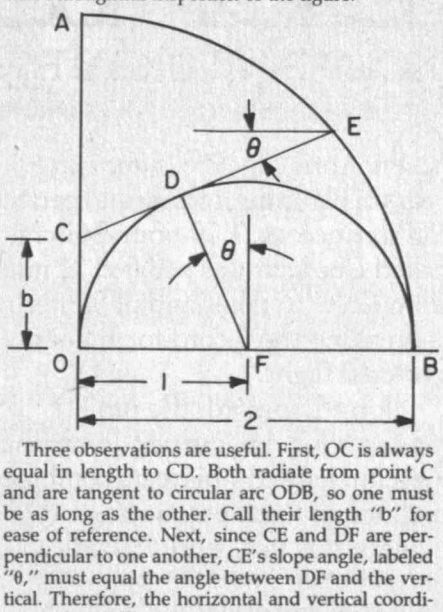
The following solution is from Robert Bart:
Trickier than it looks. If South rushes to draw trump, the play may go: heart to East, diamond return, heart to East, *low* spade to West, diamond ruff by East; down one. Why else did East duck, except to set up an entry for the ruff? South must return the Spade at trick two, killing the late entry. Subsequent play depends on how the defense continues:
If East plays a third spade, ruff low in the closed hand and then
(1) If West does not overruff, run the ♥J. Even if West is void, North can ruff the next spade and play the ♥K.
(2) If West overruffs with the ♥A, win the return and play the ♥K.
(3) If West overruffs but not with the ♥A, overruff in dummy and lead a low heart. If West follows suit and East wins to play another spade, ruff high and pull trumps. If West is now void, ruff the spade in North, come to the closed hand with a club, and play trumps.
If East shifts to a diamond at trick 3, win in the closed hand and run the ♥J.
(1) If West is out, continue trumps at every chance until East is out and then dummy is good.
(2) If West follows low, East wins with the ♥Q and returns a spade; do *not* ruff in the closed hand since this risks an overruff and a diamond ruff by East. Instead pitch a diamond, ruff in dummy, and lead the ♥K. If West ruffs with the ♥A to play a diamond, South can overruff East.

Also solved by Richard Hess, Winslow Hartford and the proposer, Doug Van Patter.

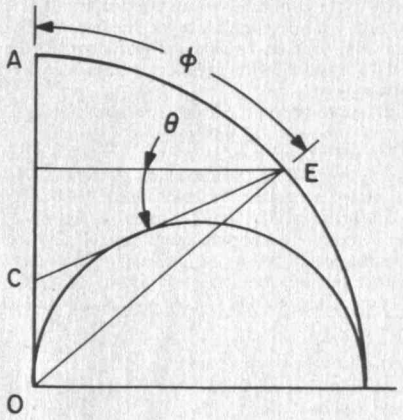
OCT 2. The figure depicts a semicircle of radius 1 in a quarter-circle of radius 2. What is the largest area that the curved region ACE may have, if CE is tangent to the semicircle?



The following solution is from John Russell:
[This problem] requires us to find the largest possible area for region ACE in the figure below. My first attempts to solve it bent my hammer and tongs and left me with cumbersome polynomials. I was happy, then, to find that the problem yielded to a more thoughtful inspection of the figure.



Three observations are useful. First, OC is always equal in length to CD. Both radiate from point C and are tangent to circular arc ODB, so one must be as long as the other. Call their length "b" for ease of reference. Next, since CE and DF are perpendicular to one another, CE's slope angle, labeled "θ," must equal the angle between DF and the vertical. Therefore, the horizontal and vertical coordinates of point D are $(1 - \sin\theta, \cos\theta)$, and the length of CD, b, must be $(1 - \sin\theta)/\cos\theta$. It follows that $\sin\theta = (1 - b^2)/(1 + b^2)$ and $\cos\theta = 2b/(1 + b^2)$. Finally, when region ACE has maximum area, CE is 2b units long. Suppose we start generating the area by moving point E up to A. Initially, OA and CE will be colinear, and the area between them will be zero. Then let point E descend towards B. DE, being longer, will generate area far more rapidly than CD can eliminate it. Net area will continue to increase until CD and DE are equal, after which CD will begin to deduct more than DE can add. Therefore, area is maximum when CD equals DE, and CE = 2b. By the law of cosines, $OE^2 = OC^2 + CE^2 - 2OC \cdot CE \cos OCE$. In terms of b and θ, $4 = 5b^2 + 4b^2\sin\theta$, or in terms of b alone, $b^4 + 5b^2 - 4 = 0$. It follows that
$b^2 = [(41)^{1/2} - 5]/2$, and
$\sin\theta = [7 - (41)^{1/2}]/[(41)^{1/2} - 3]$;
$\theta = 10°6'5''$.



We can now note that the horizontal projections of OE and CE are identical. That is, identifying angle AOE as φ, $CE\cos\theta = OE\sin\varphi$. Since the length of OE is 2, $2\sin\theta = 2b \cdot 2b/(1 + b^2)$, and $\sin\theta = 2b^2/(1 + b^2)$, $\varphi = 55°32'56''$. The area of sector AOE is therefore $OE^2\varphi/2 = 1.939$. From that we must deduct the area of triangle OCE. Letting s stand for the semiperimeter, $s = (3b + 2)/2$, and the triangle's area, $[s(s - b)(s - 2b)(s - 2)]^{1/2} = 0.6907$. The maximum area will therefore be $1.939 - 0.6907 = 1.2483$.

This solution may be too late to qualify. Mail takes a while to reach here (Scotland), and pondering the problem took more time than I like to admit. Nonetheless, it's been fun, and typing the solution has been a brand new challenge.

Also solved by John Wrench, Hy Tran, Harry Zaremba, Norman Wickstrand, Steven Feldman, Robert Bart, Richard Hess, Fred Furland, W. Kelly Woods, Turker Oktay, Dave Mohr, Robert Light, Harry Garber, and the proposer, Matthew Fountain.

OCT 3. On a train, Smith, Robinson, and Jones are the fireman, brakeman and engineer, but NOT NECESSARILY respectively. Also aboard the train are three businessmen who also have the same names: a Mr. Smith, a Mr. Robinson, and a Mr. Jones.
(1) Mr. Robinson lives in Detroit.
(2) The brakeman lives exactly halfway between Chicago and Detroit.
(3) Mr. Jones earns exactly $20,000 per year.
(4) The brakeman's nearest neighbor, one of the passengers, earns exactly three times as much as the brakeman.
(5) Smith beats the fireman at billiards.
(6) The passenger whose name is the same as the brakeman's lives in Chicago.
Who is the engineer?

Tom Campbell notes that the brakeman's nearest neighbor can't be Mr. Jones since $20K isn't divisible by 3 [rules 3 and 4]. The nearest neighbor can't live in Chicago or Detroit (Mr. Robinson) since they are equidistant [1, 2, and 6]. The nearest neighbor must therefore be Mr. Smith. Mr. Jones must live in Chicago. The brakeman must be Jones [6]. The fireman can't be Smith [5], so the engineer must be.

Also solved by Larry Marden, Ken Rosato, Gordon Rice, Matthew Fountain, Harry Garber, Harry Zaremba, Dave Spiewak, Robert Bart, Raymond Gaillard, Richard Hess, Fred Furland, Mac Zimmerberg, W. Kelly Woods, Avi Ornstein, Walter

Cluett, Walter Hicks, Martin Weinstock, and the proposer, Ron Raines.

OCT 4. Three of you in a room are told each of you has a prime number written on your forehead and that the numbers form the sides of a triangle with prime perimeter. Each person is asked in turn if he can deduce his number.
(a) You see a 5 and 7 and have heard "don't know" from the other two. What is your number?
(b) You see a 5 and 11 and have heard "don't know" from the others on each of their first two turns. You have stated "don't know" on your first turn. It is now your second turn; what is your number?

The proposer wrote to say that the problem was flawed—more conditions were needed to answer part (a). As often occurs, however, the flaw did not destroy the problem. Instead, it just changed the character. The following solution is from Matthew Fountain:
Part (a) has no solution. Part (b) has 13 as my number. I presume part (a) was posed to encourage interest in part (b) without being too obvious a clue. I do not discuss part (a) further as its features are incorporated in part (b). To make my solution easier to follow I present the following pairs of primes that might be visible to one participant, followed by the primes that could be on his forehead. When A and B are the visible primes the restrictions on C, the third prime, are $|A - B| < C < A + B$ and $A + B + C$ is prime.
3-3 (5) 3-5 (3,5) 3-7 (7) 5-7 (5,7,11)
5-11 (7,13) 5-11 (7-13) 7-7 (3,5)
I am the third responder and see 5-11. I temporarily assume it to be 7. Mr. 11, the participant I see with 11, then will see 5-7 and then will test if his number is 5. He reasons, "When I have 5, the third responder, Mr. 7, will see 5-5 and wonder if his number is 3, which would cause the first two responders to see 3-5. But then the first response of 'I can't decide' would inform the second responder that the first did not see 3-3. The second responder, seeing 3-5, could then decide that his number could not be 3 and would announce that it was 5. As he does not do this, Mr. 7, seeing 5-5, can decide his number is 7." But when he doesn't do so, Mr. 11 eliminates the possibility that his number is 5. Mr. 11 will next test if his number is 7. He reasons, "When I see 5-7 and my number is 7 then Mr. 5 sees 7-7 and will decide that his number is 5 and not 3 as soon as he hears someone else respond 'I can't decide.' For had the responder seen 3-7, the responder would have announced his number to be 7." When Mr. 5 does not announce his number his first turn after hearing someone else, Mr. 11 concludes his own number is not 7. Mr. 11 then will realize that the only possibility left is that it is 11, and announce his number to be 11. I check to make certain that it does not matter if Mr. 11 is either the first or second responder, he will still be able to decide on his second turn if he sees me with 7. Because he is unable to decide on his second turn, I announce my number is 13.

Also solved by Robert High (who developed an algorithm for a class of such problems).

OCT 5. What is the largest integer that is less than $1 + 1/2 + 1/3 + \ldots + 1/162{,}754$?

Kent Boklan writes: "It was nice to see that my old MIT friend Scott Berkenblit is still alive. To show that I am the same, I'm taking the liberty of sending a brief solution to his [problem]:
In general, call

$$S_n = \sum_{k=1}^{n} \frac{1}{k}, \; n$$

a positive integer. The desired value is $[S_{162,754}]$, which is easily seen to be 12:
For, by the Euler summation formula, indeed a handy tool,

$$S_n = \log n + Y + \int_n^\infty \frac{\{t\}}{t^2}\, dt$$

where $\log n$ is base e, Y is Euler's constant:

$$1 - \int_1^\infty \frac{\{t\}}{t^2}\, dt = .57721\ldots,$$

and $\{\alpha\}$ is the fractional part of $\alpha = \alpha - |\alpha|$. Thus

$$0 < S_n - \log n - Y = \int_n^\infty \frac{\{t\}}{t^2}\, dt < \int_n^\infty \frac{1}{t^2}\, dt = \frac{1}{n},$$

with some sharpening possible. And, for any n,

$$\log n + Y < S_n < \log n + Y + \frac{1}{n},$$

and consequently for $n = 162{,}754$, $12.577211 < S_{162,754} < 12.577217$, and we are done."

Also solved by Bill Cain, Robert Bart, Kent Boklan, John Wrench, Fred Furland, Ken Rosato, Gordon Rice, Matthew Fountain, Harry Zaremba, Jeff Abrahamson, Steven Feldman, Richard Hess, Gerald Leibowitz (who refers us to Boas, "Convergence, Divergence, and the Computer," in *Mathematical Plums* by Honsberger to see how sums of tiny numbers are calculated), and the proposer, Scott Berkenblit.

Better Late Than Never

M/J 2. Several comments have been received on the published solution, the consensus being that the problem is rather more difficult than it appears. Bob High comments that any "pure" strategy cannot be optimal; instead, some probabilistic mix of pure strategies will be needed. High supports this claim by arguing that Bart's diagram is generic, so that for any pure strategy there will be non-shaded points. High asserts that any optimal strategy for a two-person zero-sum game must remain optimal even if disclosed to the opponent, but if the opponent knows or can deduce which pure strategy is being used she can "just pick a point nearby in the non-shaded area, sit back, and wait to count [her] money." Dave Mohr recommends J.D. Williams, *The Complete Strategist*, to learn about these problems. Mohr has also proposed a discrete version of the problem, which will appear in a future issue of "Puzzle Corner."

JUL. Robert Bart responded on time to the first three problems but I inadvertantly misfiled his letter with the October solutions.

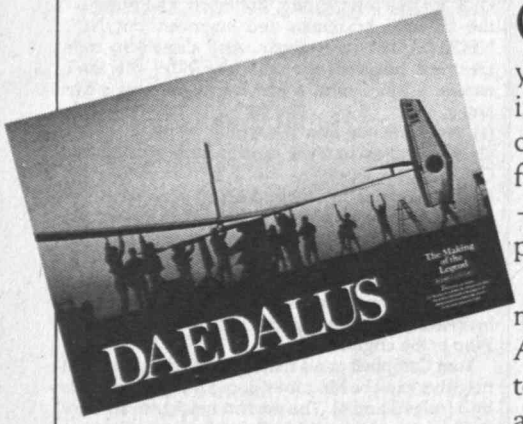
Proposers' Solutions To Speed Problems

SD 1. Zero. Volume I page 1 is adjacent to volume II page 512.

SD 2. All of them!

DAEDALUS

HOW TECHNOLOGY RECREATES A LEGEND



THE STORY OF MIT'S TRIUMPHANT DAEDALUS PROJECT IS NOW AVAILABLE IN REPRINT FORM

On April 23, 1988, after three years of planning, testing and perfecting technology, a 70-pound aircraft called *Daedalus* was pedaled 72 miles from Crete to the island of Santorini – breaking the record for human-powered flight.

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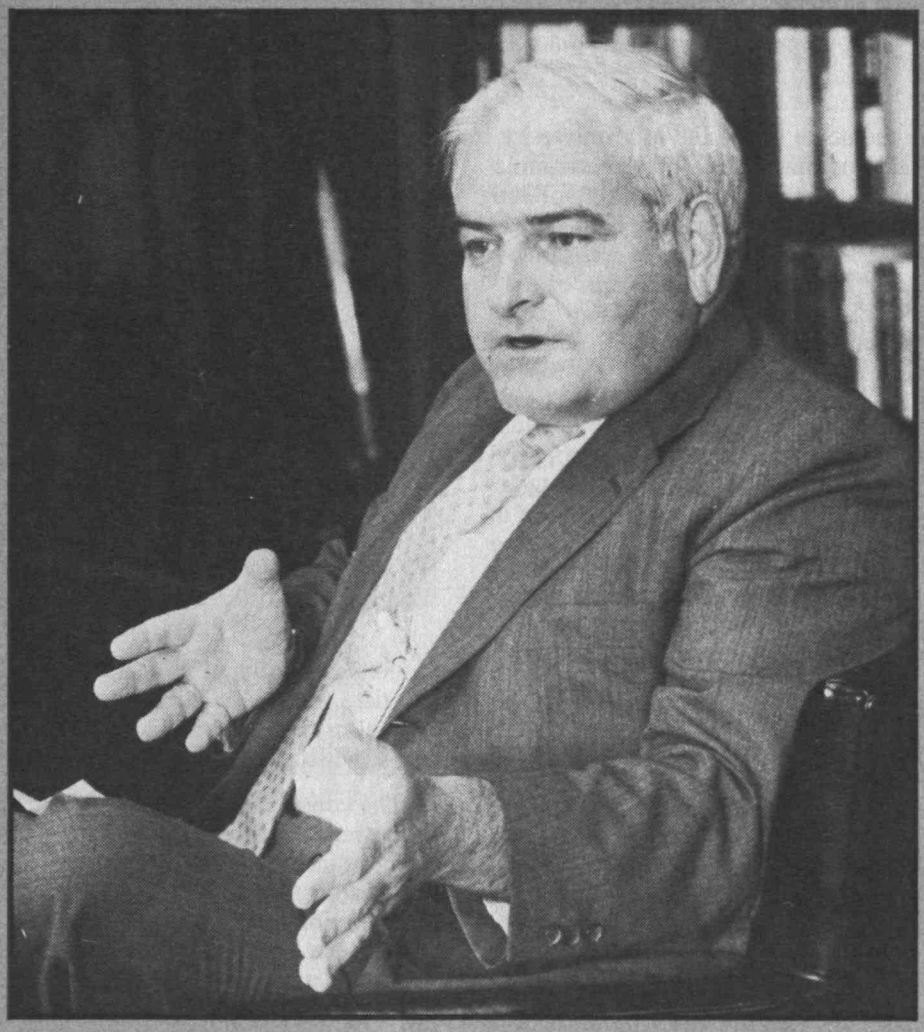
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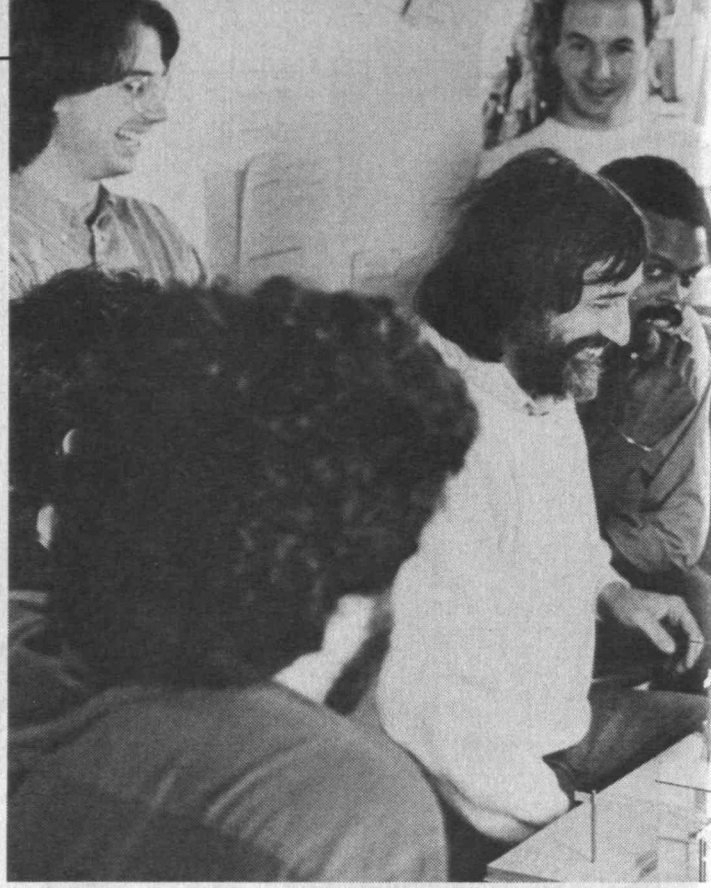
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Massachusetts Institute of Technology



Report of the President

For the Academic Year 1987-88



There are moments in the life of a university that remind us that behind all the academic programs, the organization, the press of activity, there is a vision. This past winter, MIT lost one of the major figures in its history – James R. Killian, Jr., former President and Chairman of the Corporation. As tenth president, Jim Killian embodied and articulated the best of MIT, and kept before us the vision of why this university is so special, so right for its times.

The Corporation of MIT, at its meeting in March, adopted a set of memorial resolutions that captured the significance of this man and his time in MIT's history:

> Those of us who knew him and worked with him have lost a warm and wise friend whose life we were fortunate to share. Through more than half a century of exemplary dedication to MIT, Jim Killian demonstrated rare qualities of mind and spirit. In the most critical times his perspective was invaluable in understanding and strengthening the role of technology in modern society. He initiated the postwar evolution of MIT to what he called a "university polarized around science, engineering, and the arts," a vision that gave a humanistic sensitivity to its role as a foremost institution of science and technology.
>
> Throughout an association spanning more than 60 years, Dr. Killian's contributions to MIT were enormous. His deep understanding of its goals and his wise judgment have left a mark upon the Institute that will never be forgotten. A man of enviable erudition, Jim Killian possessed as well a natural eloquence and charm, a warm and gracious manner, and a gentle, wry humor that was never unkind. All these gifts he put to use in the service of MIT. . . .
>
> Dr. Killian's commitment to public service was equally impressive. During the 1950s he served President Eisenhower in evaluating national technological and intelligence capabilities, and, as Presidential Science Adviser from 1957 to 1959, Dr. Killian put into place a strong mechanism for providing US presidents with the best scientific advice the nation had to offer. Although he was not a scientist himself, Jim Killian always had a rare and special understanding of what it means to be a scientist, and it was because of this valuable insight that he was such a great leader of scientists. . . .

The consummate servant of the public interest, he possessed a foresight and vision that brought into being official national concern for arms control and disarmament, and launched and nurtured the public broadcasting system in this country.

He once described the central challenge facing American universities as "the imperative to be relentlessly first rate, to maintain such high credibility, creativity, and luminous excellence that they enlarge the national vision and enhance the national confidence." This statement of the challenge to universities – to this university – applies with equal force and reason today, as we face the upcoming national elections and a new century that is little more than a decade away.

What role should the universities play in the national agenda, and how do science and technology, as well as basic research and education, fit into that agenda as it will be framed by the next President of the United States?

We live in a complex and even paradoxical world, a world in which security and plenty for some sets in relief a world beset by hunger, disease, pollution, and poverty for many, a world riven by political and racial discord, a world still threatened by nuclear arms. It is vital that our young scientists and engineers – and social scientists, architects, and managers – be educated to meet the challenges of

PHOTO: SUSAN LAPIDES



Students in architecture get a lot of practice in building and reviewing models. This class is working with Associate Professor Jan Wampler.

our world and our time. They must be prepared to address issues that are central to the preservation and enhancement of life and to consider critical questions about the interplay between science and technology and the social, cultural, environmental, and economic settings in which new scientific knowledge and technological applications are pursued.

MIT, Education, and the National Agenda

I do not pretend that we have all the answers or that MIT has a corner on wisdom in this domain, but we are taking a searching look at what we teach, whom we teach, and how we teach – particularly at the undergraduate level. I believe the kinds of questions we are asking, the kinds of challenges we are posing for ourselves, bear directly on the national agenda – if that agenda is to include such goals as health, prosperity, and security, not just for this nation, but for this planet.

That sounds ambitious, even presumptuous, but we are privileged to be in a special position to address these challenges. We have as our students some of the brightest young people our nation and the world have to offer. We have as our faculty a premier assembly of scholars. And we have as our mission a tradition, a legacy, of identifying and serving the needs of the society. This mission has guided the evolution of MIT with a sureness and steadiness of purpose that is one of our greatest strengths.

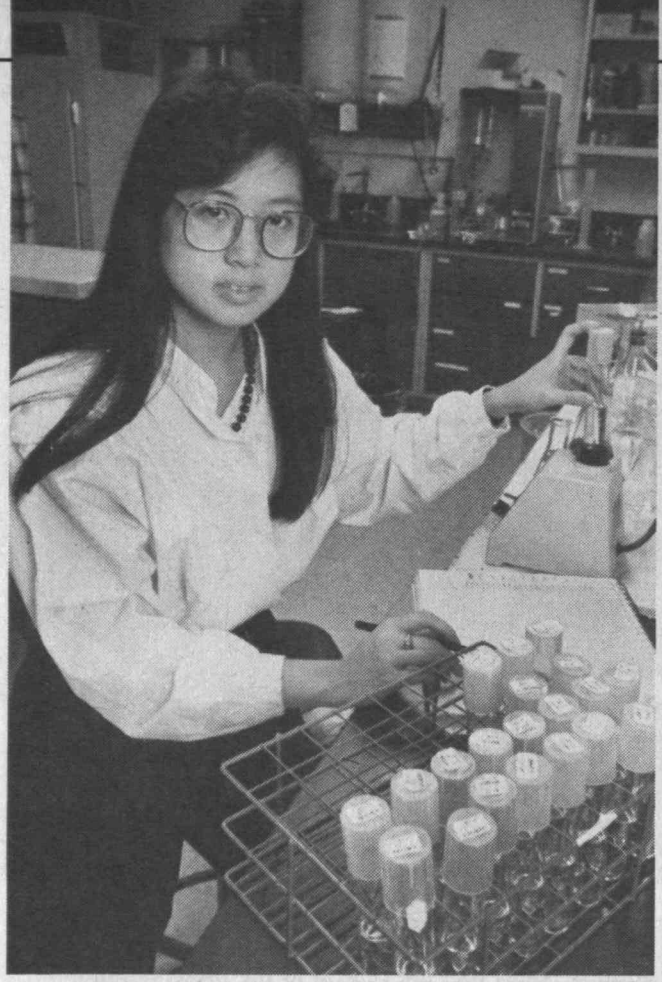
As I have noted in the past, the culture of this place, and the kind of overall educational experience that students have here, depend greatly on the interests and backgrounds of the students themselves – the culture they bring with them and the culture they create while they are here. In recent years, we have paid closer attention to the influence of our students on our educational program – recognizing that a broader range of primary intellectual commitments and social and racial backgrounds is central to our goal of encouraging our students to value different perspectives and points of view, and to recognize and be able to deal with the social, political, and economic complexities and contexts of scientific and technical enterprise.

We have achieved some success on this front. The class entering in the fall of 1987, for example, was very strong academically, exhibiting broad intellectual interests, wide cultural diversity, and a better racial balance than any previous class. We are beginning to see this increased plurality of perspectives and interests reflected in students' choices of major, a development that should underscore our efforts to develop an educational program that is better able to identify and integrate different perspectives and approaches to learning.

In my recent annual reports, I have discussed some of the ways in which the faculty has been reviewing the academic program in order to prepare our students for the kind of professional and social responsibility we deem to be appropriate for our times. We have made progress in the last year:

- We have implemented those changes affecting the General Institute Requirements in the Humanities, Arts, and Social Sciences that were adopted by the faculty late in the spring of 1987. These changes – designed to provide greater focus and rationale for the study of these fields in the core curriculum – reduce the fragmentation of distribution subjects and group them into five thematic areas of study: literary and textual studies; language, thought, and values; the arts; cultures and societies; and historical studies. This reformulation, which formally incorporates the arts for the first time, should provide greater depth and focus to this important part of every student's program.

- The faculty Committee on the Undergraduate Program has begun a thorough review of the General Institute Requirements in mathematics and



Jennifer Hwang, '91, is enriching her education by doing a UROP project in the laboratory of Professor Sallie Chisholm.

science. In our core program, we have tried to balance concerns for general education with the need for preparatory studies in basic sciences as a foundation for departmental requirements. This balancing act has led to a certain rigidity in the science core, however, and it is time to take a new look. In particular, at a time of great intellectual and practical strides in the life sciences – an area where MIT offers unsurpassed leadership and achievement – our undergraduates are currently not required to include such study in their programs. The Committee is exploring both the appropriateness of such a requirement and how it would be accommodated within the structure of the Institute Requirements. In addition, the content and style of the core physics, calculus, and chemistry subjects are being examined with an eye to reinforcing and extending the basic concepts that bridge across these subjects. In addition, one of the most passionately discussed issues is the widely felt need for additional, hands-on laboratory experiences for our undergraduates, especially at the introductory level. This review will be completed, and a recommendation will be made to the faculty, in the coming year.

• The Committee has moved beyond the formal curriculum to review several aspects of the undergraduate program that affect the style and character of education at MIT. These include grading policy – with particular emphasis on the first-year system of pass/no credit grades that has been used for the past 20 years; the structure of the first-year program, particularly the question of the content, sequence, and timing of the core science subjects; calendar and scheduling matters, including the question of the role and character of the January Independent Activities Period; and community expectations and attitudes which affect the intensity and pace of study at the Institute. These features of our program, taken together, create an environment that signals to our students the nature of the learning we expect from them, and thus deserve serious consideration.

• During the past two years we have given considerable attention to the academic advising of first-year students. One of the outcomes has been the development of personalized advising seminars, in which small groups of first-year students meet regularly with a member of the faculty who is responsible for both the content and conduct of the seminar and for the advising of the students in it. Starting from six pilot seminars two years ago, there were 25 such seminars this past year. In the coming year there will be about 60, involving 600 students, or 60 percent of the incoming class. Had we planned more seminars, we could have accommodated another 125 students who requested them. Clearly, this effort is a success.

These are but headlines about some of the explorations taking place throughout the Institute, as we seek to ensure that our educational program continues to prepare our students for full, responsible professional, social, and personal lives.

One of the most exciting such activities has come from two interschool faculty working groups that have had faculty from different fields coming together to examine the nature and conduct of undergraduate education at the Institute and, specifically, to develop new subjects and academic experiences that will directly address the relations of science, technology, and society.

I referred in my report last year to the initial stages of this effort to develop a set of "context courses" that would be taught on an interdisciplinary basis by two or more faculty from different schools. A great deal of progress has been made on this front in the past year, as faculty have developed an initial set of subjects ranging over a broad spectrum of issues, but all having a set of common objectives:

PHOTO: L. BARRY HETHERINGTON

... the kinds of questions we are asking, the kinds of challenges we are posing for ourselves, bear directly on the national agenda – if that agenda is to include such goals as health, prosperity, and security, not just for this nation, but for this planet.

• to make students more conscious of the significant commonalities that link the study of science and engineering with other branches of knowledge and to become more skillful at making such connections themselves;

• to increase understanding of nonscientific and nontechnological aspects of work in science and engineering – such as the political, economic, and managerial considerations integral to scientific and technological projects, or the social consequences of certain directions of scientific research;

• to encourage students to be more reflective about the social implications of individual actions and to motivate discussion of such issues as balancing the demands of personal and professional life.

This coming year, nine pilot subjects are being offered:

Automation, Robotics, and Unemployment
AIDS: Scientific Challenge and Human Challenge
Life and Institutions of Science
Does Technology Drive Politics?: The Decision to Build the H-Bomb
Negotiation in Engineering Systems
Engineers, Scientists, and Public Controversies
Accounting for the Social Consequences of Technological Change
Industrial Competition in the US and Asia
Learning to Design and Design for Learning

We hope that these subjects, and others still being developed, will provide students with a better understanding of how scientists and engineers go about doing what they do; how they work differently from each other, and from artists and humanists; and how the different perspectives of these various disciplines need to inform the identification and resolution of some of the most critical issues of our times.

We are just in the initial experimental phase of this program; nevertheless, I am hopeful that this type of intellectual experience may eventually become an integral part of our degree requirements. In any case, the goals and the theme of this effort reflect the essential spirit of what we are trying to do in reviewing our educational program: to enable students to understand and to integrate into their learning and work the concept of science and technology as enterprises that have enormous influence on society, and that are – in turn – shaped by social, economic, and political forces.

Educational renewal is no easy task. There will always be legitimate questions raised when we set about to improve on a good thing. Such questions are natural, they are important, and they are welcome.

In the coming year, for example, the faculty Committee on Undergraduate Admissions and Financial Aid will be looking at the nature and success of the recently admitted classes. If, and it is a big *if*, there are some real differences in performance between the more recent classes and their predecessors, we must ask ourselves to what extent such differences are due to changes in selection criteria, to what extent they are related to the general state of science education in the primary and secondary schools, and to what extent we want to accommodate our curriculum to our students, and vice versa.

In the culture of MIT, changes that address the larger issues and goals in education must be done with the leadership and participation of the faculty. While there is general recognition that these larger issues are important and should have a place in our educational program, there is often little agreement about what should be done, or how. It is clear to me, however, that we must work together to reach common understandings and consensus on these matters, and that this way of doing things takes time and talking and trying things out. Sometimes it seems enormously difficult to engage the fundamental issues with many small steps rather than giant leaps forward, but if these innovations are to become part of the culture of this place, they must be consonant with this culture.

I believe this past year has been one of progress in an enterprise that is continually evolving to meet our own highest standards. There is no question in my mind that the kind of education we provide and

the kind of students we teach will continue to play an important role in our national agenda – both in framing the important issues, and in helping our citizens and leaders to understand and participate intelligently in the development and appraisal of public policy on scientific and technological issues that bear on the well-being of our society.

Role of Science in Public Policy and a Democratic Society

Just as it is important for science-based universities to place science and technology in the broader social context – to recognize and discuss explicitly the social, political, and economic implications of science and engineering, so it is important for the more general society to incorporate a better understanding and appreciation of science and technology as practical, powerful realities in our lives.

We live in an age in which science and its technological fruits are growing in significance and influence. Few would argue with the thesis that our society, our culture, our lives have come to be increasingly dependent on technical knowledge. And yet there is widespread and increasing scientific illiteracy – even hostility to things scientific – within the general population. At the same time that there are ignorance and fear of science and technology, there are extraordinary expectations that scientists and engineers – the experts – will overcome intractable problems literally on demand, problems such as AIDS, massive hunger, or global environmental pollution.

These fundamental problems affecting all of our lives – public health issues, international security, energy, and the environment – contain major scientific and technical components, to be sure, but we make a grave mistake in this nation if we assume that the responsibility for dealing with such issues rests with the experts, with our graduates and others similarly prepared. We are at risk as a nation if we continue as we have been with a public unable to distinguish sense from nonsense in the domain of science and its applications, and with an electorate unable to comprehend the arguments arising at the intersection of science, technology, and public policy.

And that is, I submit, a major challenge for our national leaders: How should science and technology



– in education and research – fit into this nation's agenda? I believe it is time, it is past time, that high priority be given to support of the sciences and technology, particularly in the education of the general public.

Scientific literacy does not mean expertise. It means the capacity to reason in quantitative terms. It means familiarity with a basic scientific vocabulary and fundamental concepts about physical and biological processes. In sum, it means a reasonable intuition that is informed by the principles of science.

Let me give just one major example of such a public policy issue that requires a much greater level of understanding and cooperation among individuals and institutions if we are to come to grips with it. This past summer, as farmlands dried up throughout the midwest, and the temperature reached record highs throughout the land, the country awakened to the fact that something may be very wrong with our climate. The "greenhouse effect" was on everyone's lips. While it is not certain that the weather in the summer of 1988 is a consequence of global warming associated with increasing concentrations of carbon dioxide and other greenhouse gases in the atmosphere, one thing is certain. If the present rate at which greenhouse gases are being produced is not sharply curtailed, the earth will soon be warmer than it has been in 100,000 years; by the end of the 21st century it is likely to be warmer than it has been in at least two million years.

PHOTO: DONNA COVENEY



Alumna Linda Muri, '86 (left), was back on campus to join graduate student Ken Bryan and Dick Pireli of Physical Plant in one of the most intense jobs at MIT: judging the 2.70 Design Competition.

As a result of such warming, sea levels will rise dramatically, resulting in erosion of beaches and destruction of seacoast property, and changes in climate and weather patterns are likely to have major consequences for agricultural economies, for ecological systems, for all living things.

We may not know the details or be able to predict all the consequences of this global warming, but we *can* say already that efforts to slow further warming and to adapt to these temperature increases will stress the political systems of the world, will require massive changes in patterns of energy use and in energy sources, and will affect the lives of all inhabitants of the earth. The public policy issues which will arise – the choices to be made – require a much better public understanding of both the underlying science and the impact of a variety of technological matters.

Without such understanding, decisions will be made by those who have the greatest access to scientific and technical understanding and resources. These matters are too important, too permanent, to be made without broad understanding and consensus. Indeed, without such understanding and consensus, no effective action is possible.

Science and Technology and the National Agenda

There are several ways in which science and technology should find a more prominent place on the national agenda:

• First, there must be renewed support for the education of scientists and engineers. During the past 20 years, the number of students pursuing graduate studies to the doctoral level has not increased to meet the needs of the nation, and many universities find it increasingly difficult to fill faculty positions. The costs (in time and money) of pursuing a doctoral degree give pause to those who – with a master's or even a bachelor's degree – can find fulfilling, rewarding careers in business, government, and industry. At the same time, foreign citizens make up a growing percentage of graduate enrollments. At present, nearly half of the recipients of doctoral degrees in science and engineering are foreign citizens. Many of these individuals are required by our immigration laws to leave the United States upon completion of their studies, despite their own wishes to remain in this country. Consequently, they are unable to contribute to the need for researchers and university faculty here – needs that are now increasing considerably as the generation of men and women who made possible the post-war expansion of the US educational and research systems approaches retirement.

The nation responded to a similar need 30 years ago by creating fellowship programs to support graduate students. Similar programs today could have major effects without straining our already overburdened Federal budget; programs that would support 2,000 graduate students per year (a significant addition to the present doctoral enrollments in science and engineering) could be funded at an annual cost of about $48 million for any given class of students.

• At the same time, modest increases in support of university-based research programs and facilities are necessary and entirely consistent with expansion of graduate enrollments. These needs have been explicated repeatedly over the past decade, and I will not reiterate those arguments here. Suffice it to say that expanded support at the levels required could be achieved by reallocation of the present commitment of Federal funds to research and development. Of the present commitment of nearly $60 billion, only about $8 billion is devoted to university-based research. The leverage for the nation, in terms of expanded education, an invigorated flow of new knowledge and innovative ideas, and a more adequate production of researchers, would be great.



• Improvements in the general level of scientific literacy and mathematical competence require much greater attention to and emphasis on the importance of these subjects in the public schools. We need better-prepared teachers and new approaches to the teaching of science – approaches which emphasize the process and intellectual excitement of science, rather than the rote learning of facts, which engage young people in the process of learning by doing, and which emphasize the cultural and intellectual unity of science and human values. The primary responsibility for this aspect of US education rests with tens of thousands of local schools and school boards. But national leadership – particularly presidential leadership – could make a tremendous difference.

• Finally, our attention to education in science, mathematics, and engineering at all levels – indeed, our attention to education generally – must reflect the fact that the population of young people of school age in the US is now changing dramatically. Black and Hispanic children will be a much larger fraction of the age cohort by the turn of the century than they have been in the recent past, and they will comprise a much larger fraction of the work force in the 21st century than has been the case. Historically, these segments of the American population have been underrepresented at MIT and in science and engineering careers generally. We have worked hard on correcting this underrepresentation at MIT for two decades, and we will continue to do so. But there must be stronger national efforts to increase the proportion of minorities who study and pursue careers based on science, mathematics, and engineering.

The integration of science and technology into the mainstream of American education and priorities is not a self-serving goal. An educated citizenry – literate in science and technology – is vital to the well-being of our society and to the preservation of our democratic system of governance.

This is a challenge for our national leaders. And it is a challenge for MIT. Thirty years ago, at a time that was in some ways not so different from today, Jim Killian summed it up this way:

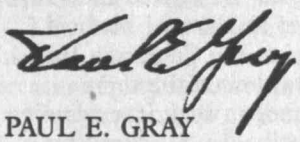
> . . . it is our continuing responsibility and opportunity at MIT to express with poise and composure the beneficent values of science and all other forms of creative intelligence and to combat the anti-intellectualism which deprecates these values. We have an unusually urgent responsibility now to stress the true character of science as a liberalizing, humanizing and creative force that serves man spiritually as well as intellectually and practically.

PHOTO: J. D. SLOAN

While the president, the faculty, and the students focus on the future, MIT Museum Director Warren Seamans ensures that the Institute doesn't lose track of its past.

Our ability to fulfill this responsibility is dependent on our greatest resource: the extraordinary quality of our faculty and students. Assuring their strength and productivity takes resources of another kind, financial resources. Last fall, we undertook the most ambitious fundraising campaign in MIT's history, the *Campaign for the future*, with a goal of raising $550 million dollars by June of 1992. The primary focus of this campaign is endowment – for faculty support, for financial aid, and for new educational initiatives and research programs. We are succeeding. When we closed the books at the end of June, we had raised just over $314 million in gifts and pledges – an extraordinary vote of confidence from our alumni and friends, and a great tribute to all of the volunteers and staff who are dedicating themselves to this tremendous enterprise.

I do not pretend for a minute that the goals of the campaign are the end. They are the means to the end: an MIT that continues to have the confidence, the ability, and the will to chart new horizons and to educate students who will help shape the course of science, technology, and society. In the final analysis, as Jim Killian said, "The wealth of an institution is not measured by money, but by its character, its excellence, its human resources, and its service."



PAUL E. GRAY

September 1988

In Special Recognition

This past year witnessed many occasions for special recognition of achievements by MIT faculty, students, and staff. Not only did we recognize our own, but it was also a year when the world took note.

This spring there was international acclaim for the successful flight of MIT's ultralight human-powered aircraft, *Daedalus*, over the Aegean Sea from Crete to the island of Santorini. The plane was designed and constructed by MIT students, faculty, and alumni to recreate the mythical flight of the Greek engineer and architect for whom it was named. Powered and piloted by Greek cycling champion, Kanellos Kanellopoulos, the 69-pound craft – flying 25 to 30 feet above the water – completed a flight of nearly 73 miles in just under four hours. This flight more than tripled the world's distance record for human-powered flight and established a new endurance record as well. It was an astonishing physiological and engineering feat, built on the dreams and dedication of the MIT team, headed by project manager John S. Langford, and supported by the generosity of several corporate sponsors and the government of Greece.

Two members of the MIT faculty were recipients of the Nobel Prize this year – Institute Professor Robert M. Solow, Department of Economics, was the recipient of the 1987 Nobel Prize in Economic Science, and Professor Susumu Tonegawa of the Department of Biology and the Center for Cancer Research won the 1987 Nobel Prize in Physiology or Medicine.

The Royal Swedish Academy in Stockholm, which administers the Nobel prizes, cited Professor Solow for his pioneering contributions to the theory of economic growth, work that goes back some 30 years to the mid-1950s. The selection committee cited his development of a mathematical model showing that long-term growth depends on technological progress, and is not driven only by increases in capital and labor. "Solow's model had an enormous impact on economic analysis," the Academy's citation said, adding that the model amounted to a "framework within which modern macroeconomic theory can be structured."

Professor Tonegawa was awarded the prize for his work that revolutionized the understanding of the human immune system. Dr. Tonegawa's work unraveled a major biological mystery: how the limited genetic complement of an animal can produce the immense diversity of antibodies that attack bacteria, viruses, and toxins. As Dr. Tonegawa explained, "Genes coding for antibodies can change during the lifetime of an individual. The problem of how our body can respond to so many different kinds of pathogens was one of the most

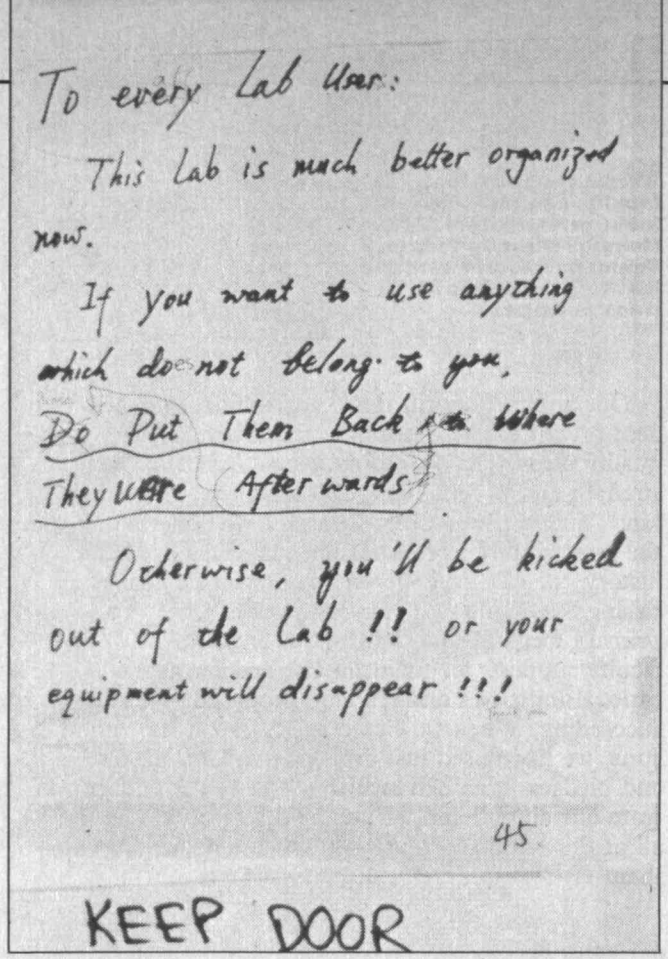
hotly debated issues in immunology. We did not understand how that happens. It turned out, contrary to what many people thought, that in the immune system genes can change during the life cycle of an individual."

In addition, Professor Tonegawa was named corecipient of the 1987 Albert Lasker Medical Research Award, considered by the medical community in the United States to be second only to the Nobel Prize in importance. He shared the 1987 award with Dr. Philip Leder at Harvard Medical School and Dr. Leroy Hood at the California Institute of Technology. The award cited the three researchers for their independent work in explaining the immense diversity of antibodies produced by the body which participate in the attack on foreign agents such as viruses and toxins.

Three members of the MIT faculty were elected members of the National Academy of Sciences. Those new MIT members are: Maurice C. Fox, Professor of Molecular Biology and Head of the Department of Biology; Ann M. Graybiel, Professor of Neuroanatomy; and Morris Halle, Institute Professor and Professor of Linguistics.

In the spring, the National Academy of Engineering elected five members of the MIT faculty to membership. New MIT members are: Barbara H. Liskov, NEC Professor of Software Science and Technology, Department of Electrical Engineering and Computer Science; Sanjoy K. Mitter, Professor of Electrical Engineering and Computer Science and Codirector of the Laboratory for Information and Decision Systems; Ronald R. Parker, Professor of Electrical Engineering and Computer Science and Director of the Plasma Fusion Center; Theodore H. Pian, Professor of Aeronautics and Astronautics; and Neil E. Todreas, Professor of Nuclear Engineering and Head of the Department of Nuclear Engineering.

Six members of the MIT faculty were elected fellows of the American Academy of Arts and Sciences. They are: Richard P. Stanley, Professor of Applied Mathematics; Mark S. Wrighton, Frederick G. Keyes Professor of Chemistry and Head of the Department of Chemistry; Sheila E. Widnall, Abby Rockefeller Mauzé Professor of Aeronautics and Astronautics; Oliver D. Hart, Professor of Economics; and Heather N. Lechtman, Professor of Archaeology and Ancient Technology and Director of the Center for Materials Research in Archaeology and Ethnology.



Professor Morris Cohen, Institute Professor Emeritus and renowned metallurgical scientist, was chosen to receive the Kyoto Prize in Advanced Technology. Professor Cohen was awarded the prize in November 1987 in Kyoto, Japan. Dr. Cohen has made major contributions to the understanding of the structure of matter and the ways in which various materials, particularly iron and steel, can be processed to provide controlled structures and improved properties.

In June 1988, it was learned that the Inamori Foundation of Japan selected Noam A. Chomsky, Institute Professor and Professor of Linguistics, to receive one of the 1988 Kyoto Prizes. Three Kyoto Prizes are awarded each year – in Advanced Technology, Basic Sciences, and Creative Arts and Moral Sciences. Professor Chomsky won the prize in the basic sciences for his theories on the nature of language that have revolutionized linguistic science.

In the spring, the President of the Italian Republic, Francesco Cossiga, presented the 1988 De Gasperi Prize in science, the highest award given by the Italian Republic, to MIT Professor of Physics Samuel C. C. Ting. This marked the first time that the De Gasperi Prize in science was awarded to a non-Italian. Dr. Ting was cited for his contributions to "the progress of science in one of the most advanced sectors of peaceful research [and] also because of his involvement in promoting international scientific collaboration for a science without secrets and without frontiers, through his active

PHOTO: BRADFORD F. HERZOG

Alumni and alumnae won't be surprised to hear that the best way to stay informed around the 'Tute is still to read the stuff posted on the walls. (And note, even the walls are edited!)

participation in establishing the World Lab and in realizing his programs of scientific and technological collaboration, east-west-north-south."

Dr. Sheila E. Widnall, Abby Rockefeller Mauzé Professor of Aeronautics and Astronautics, received the prestigious Bradford Washburn Award from the Boston Museum of Science in the fall of 1987. The award is given annually to a person who has made "an outstanding contribution toward public understanding of science, and appreciation of its fascination and the vital role it plays in our lives." Professor Widnall was particularly cited for the role she has played as president of the American Association for the Advancement of Science in guiding that organization which influences sciences policy for the country.

Within the Institute, John S. Waugh, Professor of Chemistry, was selected as the 1988-89 recipient of the James R. Killian, Jr., Faculty Achievement Award. Established in 1971 as a tribute to Dr. Killian, MIT's tenth President and former Chairman of the Corporation, the award recognizes extraordinary professional accomplishment and service to the Institute. The committee's citation said in part: "Recognized widely as an authority on physical chemistry, John has contributed to the intellectual life of the Massachusetts Institute of Technology in many respects. His fine mentorship qualities have enriched his many students, postdoctoral associates, and faculty colleagues. He has been a role model for junior faculty and faculty at other leading academic institutions. John's infectious enthusiasm for quality science has spawned one of the finest physical chemistry programs in the world."

In the late spring, Peter C. Perdue, Associate Professor of History, was named the 1988 recipient of the Harold E. Edgerton Faculty Achievement Award. The award is given annually to a junior faculty member who has made outstanding contributions in research, teaching, and service to the MIT community. The selection committee noted in its citation: "Peter Perdue is distinguished, in short, by his contributions and achievements as a contemporary historian of China, by his vocation for teaching and the range of his contributions to MIT's educational program, and by his willingness and ability to work innovatively on projects that demand collaboration with people in other departments and schools."

In April, MIT honored former president and chairman Howard W. Johnson for "two decades of brilliant and caring leadership" in naming the Athletics Center for him and announcing both the establishment of the Howard W. Johnson Professorship of Management and the creation of a Sloan School lecture series in his name. The official resolution of the MIT Corporation naming the Athletics Center for him praised Howard Johnson as "a man of uncommon vision and dedication, whose clarity, wit, and wisdom have added over many years to the stature of MIT. . . ."

This past year several key leadership roles at the Institute changed, and those transitions were occasion for special recognition.

New department or program heads announced during the past year are: Robert J. Birgeneau, Head, Department of Physics; Richard M. Douglas, Head, History Section, Department of Humanities; David M. Epstein, Head, Music and Theatre Arts Section, Department of Humanities; Thomas H. Jordan, Head, Department of Earth, Atmospheric, and Planetary Sciences; J. David Litster, Director, Francis Bitter National Magnet Laboratory; Earll M. Murman, Director, Project Athena (effective September 1988); Ronald R. Parker, Director, Plasma Fusion Center; William L. Porter, Head, Department of Architecture; and Bernhardt J. Wuensch, Director, Center for Materials Science and Engineering.

Major changes in the Institute's central administration during the year included the appointment or promotion of the following individuals: Donna M. Behmer, Assistant Dean for Administration at the Sloan School of Management; H. Eugene Brammer, Associate Director for Operations of Physical Plant; Anne P. Glavin, Chief of the MIT Campus Police; Lawrence E. Maguire, Director of Housing and Food Services; Kathryn W. Lombardi, Director of Public Relations Services and Executive Assistant to the President; Travis R. Merritt, Associate Dean for Student Affairs.

* * *

The Institute was saddened this year by the deaths of several longtime friends and colleagues.

As I noted at the beginning of this report, the Institute this year marked the passing of James R. Killian, Jr., former president and chairman of MIT, the first science advisor at the White House and a key figure in developing American educational and scientific policy during the mid-20th century. Dr.

Softball player Lori Hart, '90. Only Harvard fields more intercollegiate teams than MIT.

Killian died in January 1988 at the age of 83. For some 60 years Dr. Killian's life was intimately involved in the development of MIT as one of the leading scientific universities in the world. He served as president of MIT from 1949 to 1959 and then as chairman of the Corporation until 1971, a 22-year period marked by great expansion and building, by increases in graduate study and in research, and by expansion of the humanities and social sciences. Dr. Killian was a leading spokesman for educational innovation and curriculum reform; for the strengthening and broadening of engineering education; and for greater support of basic research. As Special Assistant for Science and Technology to President Dwight D. Eisenhower, he played a key role in laying the groundwork for what became the National Aeronautics and Space Administration – NASA – and guided it, as President Eisenhower wanted, toward civilian rather than military control. Dr. Killian also was a leader in establishing public television and public radio, wherein he saw a new technology in the public interest. He was a man of vision, grace, wit, and wisdom who devoted the full measure of his extraordinary energies and skills to MIT. It was always our good fortune that Jim Killian cast his lot with us – we are all the better for having known him.

Walter J. Beadle, life member emeritus of the Corporation and the Corporation's most senior member, died in February 1988. A member of the Class of 1917, he interrupted his studies to serve in World War I and received his S.B. degree in 1920. He joined E. I. duPont de Nemours Co. in 1928, retiring from the company in 1958 and from its Board of Directors in 1975.

In May 1988, Russel DeYoung, former chairman of the Goodyear Tire and Rubber Company, died at the age of 79. Mr. DeYoung was a life member emeritus of the MIT Corporation and a graduate of the Sloan Fellows Program. He served with the Goodyear Tire and Rubber Company from 1927 until his retirement in 1974, after which he continued to serve as director and chairman of the board's executive and finance committee until 1979.

Charles Stark Draper, founder of Draper Laboratory and Institute Professor Emeritus, died in July 1987 at the age of 85. Known as the "father of inertial guidance," Doc Draper evolved the theory, invented and developed the technology, and led the effort which brought inertial navigation to operational usage in aircraft, submarines, missiles, and space vehicles. During his early association with MIT, Dr. Draper's small team of students and technicians expanded to become the Instrumentation Laboratory. In 1973, the laboratory became a separate, independent, nonprofit research and development laboratory located in Cambridge and known as the Charles Stark Draper Laboratory.

In April 1988, George G. Harvey, professor emeritus of Physics, died at the age of 80. Professor Harvey retired in 1973 after nearly 40 years at MIT as a faculty member in the Department of Physics and a long affiliation with the Research Laboratory of Electronics. He was well known for his studies on X-ray scattering and atomic structure as well as for his research in electron microscopy.

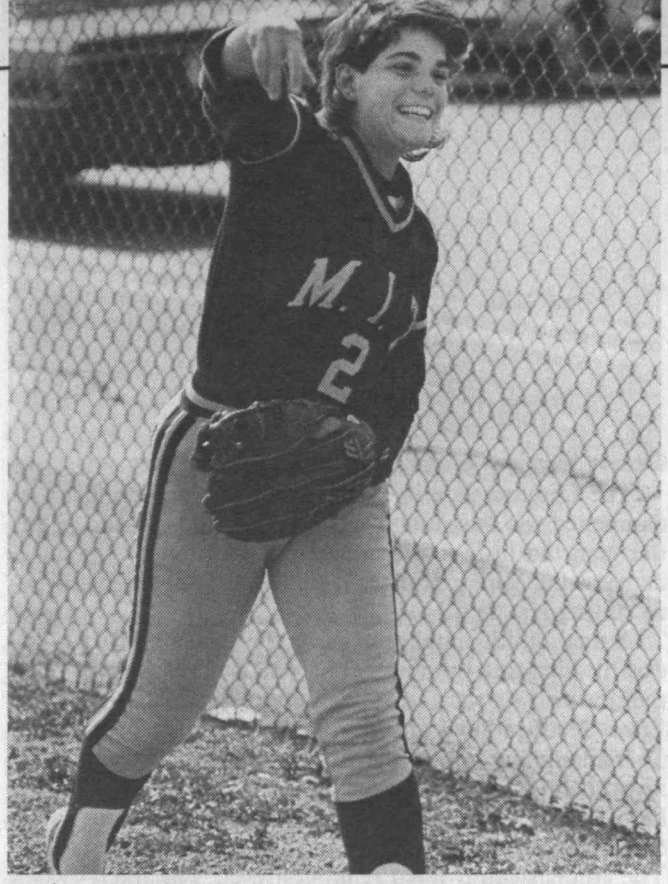
Henry G. Houghton, a pioneer of modern meteorology and a researcher and faculty member at MIT since 1928, died in October 1987 at the age of 82. Professor Houghton, who made important contributions in cloud physics and atmospheric radiation, was a founder of the National Center for Atmospheric Research and the first chairman of the University Corporation for Atmospheric Research.

Richard F. Koch, professor emeritus and former faculty member of the Foreign Languages Section in the Department of Humanities, died in October 1987 at the age of 92. Professor Koch joined the MIT faculty in 1939, serving in the foreign languages section until his retirement in 1961.

William T. Lindley, head of Lincoln Laboratory's Microelectronics Group, died in January 1988 at the age of 49. A member of the Lincoln Laboratory staff since 1965, Dr. Lindley was instrumental in developing semiconductor processing technology, including major contributions in semiconductor infrared lasers and detectors.

Jean F. Louis, Professor of Aeronautics and Astronautics at MIT for the past 19 years, died in June at the age of 56 in an automobile accident. Professor Louis was an expert in aircraft propulsion and in magneto-hydrodynamic power generation, which utilizes flowing ionized gases in magnetic fields. He recently had taken a strong interest in means for shifting the technological effort of the United States from military research and development toward space technology and energy systems.

Parry Moon, associate professor emeritus in the Department of Electrical Engineering, died in March 1988 at the age of 90. He was an authority



on illuminating engineering, vision, and color. In 1924, he joined the electrical engineering department at MIT as assistant to Vannevar Bush, studying the experimental basis of relativity and high-voltage insulation. He was deeply involved in current research on alternative formulations of electrodynamics at the time of his death.

Fred C. Schweppe, professor of electrical engineering at MIT for 22 years, died in July 1988 at the age of 54. A specialist in electric power systems operations and pricing, he became a full-time member of the MIT faculty in 1968. The breadth of Professor Schweppe's work was shown over the past decade as he and others developed a set of rate structures for the electric power industry described in a recently completed book, *Spot Pricing of Electricity*.

Lt. Charles R. Souter, an MIT graduate who was an instructor in the Naval Reserve Officers Training Corps unit at MIT for the past two years, died in May 1988 at the age of 27 in a car accident. Lt. Souter received the S.M. in mechanical engineering from MIT in 1983 and was commissioned as an officer in the Navy from the MIT Naval ROTC Program.

G. Gardner Swain, professor emeritus of Chemistry, died in March 1988 at the age of 70. Professor Swain's 40-year career at MIT began in 1946 with an American Chemical Society Fellowship in the laboratory of the late Arthur C. Cope. He was widely known for his research in physical organic chemistry and the mechanisms of reactions.

Statistics for the Year

The following paragraphs report briefly on various aspects of the Institute's activities and operations during 1987-88.

Registration

In 1987-88, student enrollment was 9,565, compared with 9,756 in 1986-87. This total comprises 4,377 undergraduates (compared with 4,443 the previous year) and 5,188 graduate students (compared with 5,313 the previous year). The international student population was 1,880 (not including permanent residents), representing 8 percent of the undergraduate and 30 percent of the graduate population. These students were citizens of 90 countries.

In 1987-88, there were 2,389 women students (1,384 undergraduate and 1,005 graduate) at the Institute, compared with 2,340 (1,295 undergraduate and 1,045 graduate) in 1986-87. In September 1987, 358 first-year women entered MIT, representing 36 percent of the freshman class.

In 1987-88, there were 1,475 minority students (1,236 undergraduate and 239 graduate) at the Institute, compared with 1,344 (1,124 undergraduate and 220 graduate) in 1986-87. Due to changes in Federal guidelines, the numbers beginning in 1986-87 include students with permanent residence status. Minority students in 1987-88 included 292 Blacks (non-Hispanic), 19 Native Americans, 305 Hispanics, and 859 Asian Americans. The first-year class entering in September 1987 included 349 minority students, representing 35 percent of the class.

Degrees Awarded

Degrees awarded by the Institute in 1987-88 included 1,150 bachelor's degrees, 1,056 master's degrees, 49 engineer's degrees, 516 doctoral degrees – a total of 2,771.

Student Financial Aid

During the academic year 1987-88, the student financial aid program was again characterized by an increase in the overall need for financial aid and in the aggregate amount of grants made available. There was an overall increase in the amount of MIT loans awarded, and Guaranteed Student Loans obtained from commercial sources also showed an increase.

PHOTO: BRADFORD F. HERZOG

A total of 2,367 undergraduates who demonstrated the need for assistance (54 percent of the enrollment) received $17,849,000 in grant aid and $3,213,000 in loans. The total, $21,062,000, represents a 6 percent increase in aid compared to the previous year.

Grant assistance to undergraduates was provided by $5,379,000 in income from the scholarship endowment, by $2,353,000 in outside gifts and Federal allocations to MIT for scholarships, and by $3,148,000 in direct grants from outside sources, including ROTC, to needy students. In addition, $6,969,000 in scholarships from MIT's unrestricted funds was provided to undergraduates, inclusive of the special program of scholarship aid to minority group students which represented $105,000 from unrestricted funds. An additional 687 students received grants from outside agencies, irrespective of need. The undergraduate scholarship endowment was increased by the addition of $4,416,000 in new funds, raising the principal of the endowment by 10 percent, to $50,864,000.

Loans totaling $3,213,000 were made to needy undergraduates – an 11 percent decrease from last year. Of this amount $735,000 came from the Technology Loan Fund and $2,478,000 from the National Direct Student Loan Fund. Not included in the foregoing summary is an additional $5,068,000 obtained by undergraduates from state-administered Guaranteed Loan Programs and other outside sources.

Graduate students obtained $1,311,000 from the Technology Loan Fund. In addition, $594,000 was loaned by MIT under the Guaranteed Student Loan Program. The total, $1,905,000, represents a 52 percent increase over last year's level, which reflects the success of an improved electronic linkage between the Student Financial Aid Office and the Massachusetts Loan Guarantee Office. Graduate students obtained $3,473,000 from outside sources under the Guaranteed Student Loan Program – about the same as last year. The total loaned by MIT to both graduate and undergraduate students was $5,118,000, a 5 percent increase over last year.

[NOTE: All of the numbers reported in this section reflect awards from the academic year perspective, and so will not match exactly the fiscal-year-based records reported by the Comptroller or the Treasurer.]

Career Services and Preprofessional Advising

The October slide in the stock market, which dampened the mood on Wall Street for the rest of the year, did little to discourage the economy or the demand for MIT graduates. Even Wall Street came recruiting.

A total of 423 employers came through the office, exactly the same number as the year before. Among them were 19 government agencies, 14 architectural firms, 3 educational organizations seeking teachers, 15 management consulting firms, and 28 banks and investment houses. Interviewing by students was light in the fall term, but by the end of the year, over 1,600 students had had some 9,600 interviews. The student count was the highest ever. The interview count was a drop from the previous year's figure of 10,500, but above the level of 1984-85 or 1985-86.

Salaries offered to graduates this year rose at different rates across the various disciplines. Bachelors in aeronautics and astronautics and in mechanical engineering saw little or no increase over 1986-87. Salaries for Bachelors in electrical engineering rose 3.1 percent over last year and chemical engineering offers were up 4.3 percent. Bachelor's graduates seeing the highest increase in salaries were those in computer science (up 5.4 percent) and those in management science (up 6.6 percent). Offers to master's graduates were similarly mixed, increasing less than three percent in chemical engineering and mechanical engineering. Doctoral candidates in aeronautics and astronautics and in electrical engineering enjoyed the same rising market as master's candidates in those fields. The median offer to Ph.D.s in electrical engineering – $54,700 – was up 6.8 percent over 1986-87.

There were 111 MIT applicants to medical school, down from 113 in 1986-87. They included 86 undergraduates, 9 graduate students, and 16 alumni. The number of undergraduates was 22 more than the previous year, one less than in 1985-86. The number of undergraduate applicants has fluctuated before, so it is too early to tell if this year's count represents a trend. The number of female applicants – 50 in all – was the highest ever, which continues a three-year old trend. To date, 80 percent of the undergraduate applicants have been accepted, close to the same percentage accepted by this date last year. By the start of the academic year last

September, 91 percent of last year's undergraduate applicants had been accepted. We look forward to similar acceptance rates during the 1988-89 year.

Finances

As reported by the Vice President for Financial Operations and the Treasurer, the total financial operations of the Institute, including sponsored research, amounted to $944,226,000, an increase of 7 percent over 1986-87. Education and general expenses – excluding the direct expenses of departmental and interdepartmental research and the Lincoln Laboratory – amounted to $383,403,000 during 1987-88, compared to $359,896,000 in 1986-87. The direct expenses of departmental and interdepartmental sponsored research on campus increased from $184,526,000 to $194,417,000 and direct expenses of the Lincoln Laboratory's sponsored research increased from $338,062,000 to $367,156,000.

Current revenues used to meet the Institute's operating expenses totaled $940,658,000, augmented by $4,318,000 in unrestricted gifts. After meeting these expenses, a surplus of $200,000 in current unrestricted gifts was held at year-end.

The major renovation work in the Julius A. Stratton Building (housing the Student Center) and the Plasma Fusion Center continued during the year and the book value of educational plant facilities increased from $324,406,000 to $334,150,000.

At the end of the fiscal year, the Institute's investments, excluding retirement funds, student notes receivable, and amounts due from educational plant, had a book value of $1,064,202,000 and a market value of $1,396,607,000. This compares to book and market values of $917,464,000 and $1,396,716,000 last year.

Gifts

Gifts, grants, and bequests to MIT from private donors increased by 22 percent in 1987-88 to a new high of $83,716,000, as compared to $68,331,000 in 1986-87. The Alumni Fund reported gifts of $12,372,000 for the year.

The Institute announced the *Campaign for the future* on October 22, at which time $210 million in gifts and pledges had already been raised toward the $550 million goal. By year-end, the total exceeded $314 million from alumni, friends, corporations, and foundations. A large number of events were held both on and off campus to inform our donors of the quality of the Institute's programs and more are planned for the coming year. The Campaign is primarily directed at increasing endowment, particularly for professorships, student aid, research, and unrestricted funds. The many volunteers, faculty, and staff that are devoting their efforts to the Campaign provide optimism for continued success.

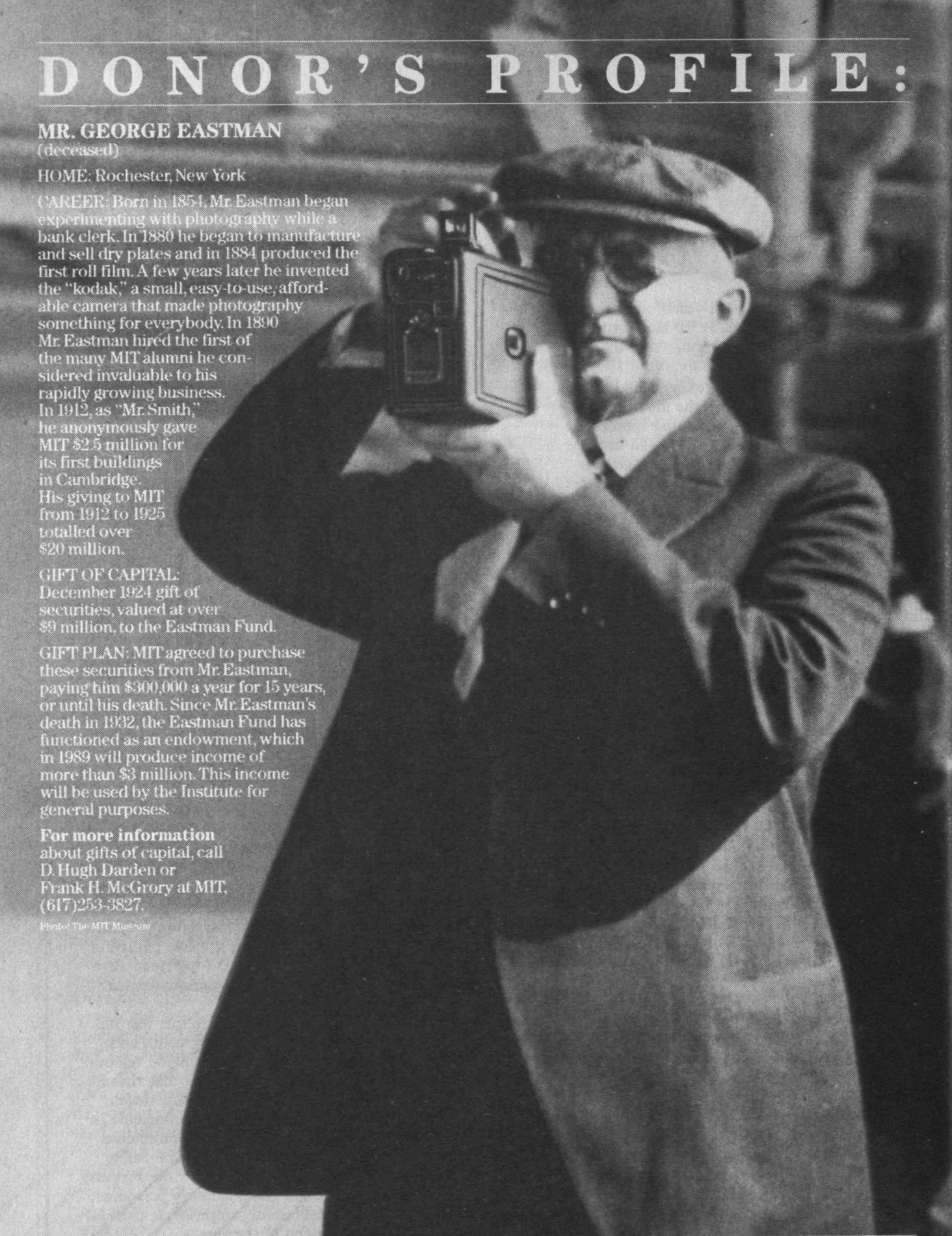
Physical Plant and Campus Environment

Major construction activities this year included substantial completion of accommodations for an additional 29 graduate students at Ashdown House and significant progress on the renovation of the Stratton Building, scheduled to reopen in the fall. Preliminary design was completed for the renovation of 143 Albany Street into housing for 185 married and single graduate students, design was initiated for an addition to Building 7 that will allow for expansion of the Rotch Library, and a planning study in preparation for the design of a new biology building to be constructed on a portion of the former TRW/Carr Fastener site was begun.

This year the Institute continued its commitment to energy conservation and associated cost avoidance by initiating work on a formal retrofit program in conjunction with Cambridge Electric Light Company's electricity conservation rebate program. Over the next year, we anticipate carrying out $3.7 million of construction that will touch almost every room on campus. Installation of new, more efficient electric devices, controls, motors, and lighting equipment will generate savings and rebates with a value of over $1.5 million annually. During the first three years, while the cost of construction is being amortized, the Institute's net energy cost reduction will average approximately $500,000 per year. Beginning in 1993, essentially all of the savings will be available for other purposes.

Significant progress was also made this year on two important campus environmental health and safety issues, namely, the identification and removal or encapsulation of asbestos-containing materials and the identification and removal of polychlorinated biphenyl (PCB)-containing electrical equipment. In addition, a renewed effort was undertaken to clear Institute corridors of all obstructions. The Safety Office, with the help of Physical Plant, the Property Office, and departmental and laboratory personnel, completed a highly successful campus-wide corridor clean-up prior to the end of the year.

DONOR'S PROFILE:



MR. GEORGE EASTMAN
(deceased)

HOME: Rochester, New York

CAREER: Born in 1854, Mr. Eastman began experimenting with photography while a bank clerk. In 1880 he began to manufacture and sell dry plates and in 1884 produced the first roll film. A few years later he invented the "kodak," a small, easy-to-use, affordable camera that made photography something for everybody. In 1890 Mr. Eastman hired the first of the many MIT alumni he considered invaluable to his rapidly growing business. In 1912, as "Mr. Smith," he anonymously gave MIT $2.5 million for its first buildings in Cambridge. His giving to MIT from 1912 to 1925 totalled over $20 million.

GIFT OF CAPITAL: December 1924 gift of securities, valued at over $9 million, to the Eastman Fund.

GIFT PLAN: MIT agreed to purchase these securities from Mr. Eastman, paying him $300,000 a year for 15 years, or until his death. Since Mr. Eastman's death in 1932, the Eastman Fund has functioned as an endowment, which in 1989 will produce income of more than $3 million. This income will be used by the Institute for general purposes.

For more information about gifts of capital, call D. Hugh Darden or Frank H. McGrory at MIT, (617)253-3827.

Photo: The MIT Museum

MIT LIFE INCOME FUNDS



This isn't just a baggage tag. It's a contract.

We don't think a system of handling baggage should leave anything to chance. Which is why we take so many precautions. Like writing baggage tags by computer and not by hand (handwriting, unfortunately, is often subject to interpretation).

Our system works so well that we guarantee you *and* your baggage a smooth trip. And we back that guarantee with cash. If you or your baggage miss a connecting Lufthansa flight when you fly Lufthansa First or Business Class across the Atlantic, we will pay you $200.

Call it a contract. We do. Everywhere we fly. On 6 continents, in 82 countries, in 161 cities.

People expect the world of us.

Lufthansa
German Airlines

Lufthansa is a participant in the mileage programs of United, Delta, and USAir. See your Travel Agent for details.



THE OFFICE WALL AT THE "GRANDMOTHERS OF THE PLAZA DE MAYO" IS PLASTERED WITH PHOTOGRAPHS OF A FEW OF ARGENTINA'S 9,000 "DISAPPEARED."



Forensic scientists have long defended human rights. Now they are using their skills to aid victims of state terror.

Scientists as DETECTIVES

Investigating Human Rights

BY CLYDE COLLINS SNOW, ERIC STOVER, AND KARI HANNIBAL

In 1988, Amnesty International accused 135 nations of human-rights violations ranging from illegal arrests to massacring unarmed civilians. "In at least half the nations of the world," the organization said, "people are locked away for simply speaking their minds, often after trials that are no more than a sham. In scores of other countries, governments pursue their goals by kidnapping and murdering their own citizens."

Equally disturbing are reports that scientists in several countries have participated or collaborated in torture and abuse. Some physicians directly or indirectly use their skills to inflict needless suffering. They falsify medical certificates and autopsies, design new methods of abuse, diagnose political and social nonconformists as suffering from serious psychiatric disorders, or even conduct torture themselves.

Grim as such professional abuse may be, a growing number of scientific and medical associations are working to end the exploitation of medicine as a punitive weapon of the state. Since 1982, for instance, the Chilean Medical Association has disciplined six of its members for collaborating in torture conducted by the government of Gen. Augusto Pinochet. The associa-

PHOTO: WILLIAM ALBERT ALLARD

"In those sacks," our host told us, "are the bones of maybe 20 or more people —the so-called desaparecidos."

tion has also issued guidelines informing physicians of their professional responsibilities to report to it within five days any torture cases that they may encounter in police and military prisons. Elsewhere in Latin America, notably in Argentina and Uruguay, medical and human-rights organizations are urging legislators to stiffen penalties for medical personnel who mistreat detainees.

But beyond speaking out on behalf of persecuted colleagues and against professional misconduct, is there more that scientists and their professional associations can do?

The answer is yes. Five years ago, on a bitterly cold morning, two of us were present when a group of U.S. forensic scientists huddled together in a small autopsy room in Córdoba, Argentina. Our host, the director of the city morgue, spoke in rapid Spanish. Unaccustomed to speaking through an interpreter, he frequently paused as his words were translated. "In those sacks," he said, motioning to the side of the room, "are the bones of maybe 20 or more people—the so-called *desaparecidos*." Several weeks earlier, morgue workers had removed the remains from a mass grave containing 300 bodies, all of people believed to have been "disappeared."

Argentina's period of military rule had ended in December 1983. Over seven long years, government death squads had murdered at least 9,000 people. The country's new president, Raul Alfonsin, pledged to investigate and punish those responsible, and he ordered the prosecution of the junta leaders. He also created the Argentine National Commission on Disappeared Persons, a blue-ribbon commission to probe the fate of the disappeared. The U.S. scientists, assembled by the American Association for the Advancement of Science (AAAS) and funded by the Ford and J. Roderick MacArthur foundations, had traveled to Argentina to lend technical expertise to the work of the commission. It was an emotional and sobering experience for us, visiting morgues and cemeteries throughout the country and viewing endless mounds of plastic bags containing bones recently exhumed from individual and mass graves.

In Search of the Disappeared

President Alfonsin's commission faced seemingly insurmountable problems when it began its search in early 1984. For nine months, it took testimony from military and police personnel, surviving detainees, and relatives of the disappeared. Investigators combed scanty military records for clues to the whereabouts of the missing. What emerged was a chronicle of state-imposed terror.

"In my case," Elena Alfaro told the commission, "I was made to watch the torture of my husband." Irma Beatriz Marquez was forced to witness the torture of her 12-year-old son, Pablo. Some detainees, particularly the elderly, died under torture. Others were eventually freed or transferred to officially recognized jails or prisons from one of the 360 secret detention centers.

Most detainees were secretly executed without charge or trial, and government death squads disposed of the bodies in ways that would conceal the crimes. They dropped some victims from military aircraft over the Atlantic or the estuary of La Plata River and incinerated others in crematoria or open pits. One police officer told the commission that at a secret detention center called El Banco, the police "made what they called 'traps,' which were rectangular pits 50 or 60 centimeters deep and 2 meters long. I saw these pits, the size of a person. . . . They put human bodies inside these pits, sprinkled them with petrol . . . and burnt them to ashes."

In most cases, however, military or police squads delivered the bodies of their victims to municipal morgues, where the police surgeon examined them cursorily. This violated Argentine law, which requires that a police surgeon or a pathologist from a municipal morgue fully examine any victim of a violent or suspicious death. The examiner is supposed to report the findings to a judge, who rules on whether the deceased died of natural causes or was a victim of an accident, suicide, or homicide. Although the bodies—dead only a few hours—could have been identified by fingerprints or dental records, no attempt was made to do so.

Many morgue workers were well aware of the atrocities committed around them. Some told of army trucks arriving at morgues late at night, and of unloading bodies, often mutilated and bearing signs of torture. Officers ordered the morgue workers not to perform

CLYDE COLLINS SNOW has directed the scientific search for the disappeared in Argentina since 1984. He is a consultant in forensic anthropology to several U.S. medical examiner's offices and law-enforcement agencies. ERIC STOVER is staff officer and KARI HANNIBAL is acting director of the Science and Human Rights Program of the American Association for the Advancement of Science. Stover is co-authoring a book about the use of forensic anthropology in criminal and human-rights investigations, to be published late this year by Little, Brown, Inc. With Philippine human-rights organizations, Hannibal organized a workshop in the forensic sciences in December 1986

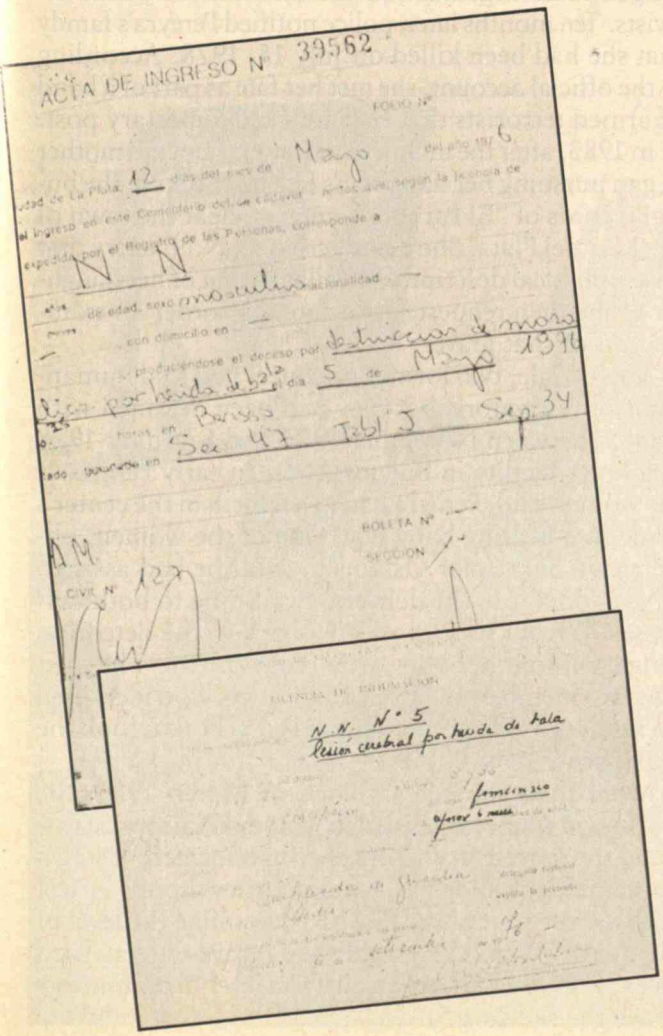


autopsies and simply to register the bodies, designated "N.N." in cemetery files, for *ningun nombre*—"no name," for burial in unmarked graves. Some morgue workers quietly left their jobs—one pathologist suffered a nervous breakdown—but others went on with their work.

Families of the disappeared were virtually helpless in their attempts to determine the fate of their loved ones. In a few cases, morgue officials informed families of the death of a detained relative and provided a grave plot number. Even so, judges were generally unwilling, out of either fear or indifference, to order an exhumation for forensic examination.

That changed shortly after the Alfonsin government took power, when several judges, who were unable to order investigations during military rule and were anxious to determine if cemeteries contained the remains of the disappeared, ordered hundreds of N.N. graves excavated. Cemetery grave diggers aided by heavy dirt-moving equipment performed the exhumations, and the result was disastrous. Human-rights lawyers realized that little usable medical or legal evidence would be recovered from these grisly harvests.

As bulldozers and workers with spades heaped mounds of bones next to the opened graves, the callous mishandling of the remains drew angry protests from the families of the disappeared. Also, as the AAAS delegation pointed out at the end of our visit in June 1984, forensic scientists, no matter how well equipped, could not work with evidence that failed to reach the laboratory. During these mass exhumations, clues—bones, teeth, hair, clothing, and bullets—had been lost or destroyed. These objects are vital to identifying the victim and determining the time, cause, and manner





LEFT: MANY BODIES OF PEOPLE KILLED BY THE POLICE AND MILITARY COULD HAVE BEEN IDENTIFIED. INSTEAD, MORGUE WORKERS WERE ORDERED TO LABEL THEM N.N.—NO NAME—IN CEMETERY RECORDS.

ABOVE: MEMBERS OF THE ARGENTINE FORENSIC ANTHROPOLOGY TEAM BEGIN EXCAVATING A MASS GRAVE NEAR BUENOS AIRES. THE GRAVE IS BELIEVED TO CONTAIN THE REMAINS OF OVER 200 PEOPLE MURDERED BETWEEN 1976 AND 1978.

PHOTOS: AAAS/CHRISTOPHER JOYCE



of death. Furthermore, notes and photographs should have carefully documented spatial evidence—such as the location of a particular bullet fragment relative to a fractured bone.

As a result, we urged the commission to employ professional archaeologists, who would conduct the exhumations using the same methodology they had long applied to recovering prehistoric remains. One grave excavated using archaeological techniques would yield more evidence than several hundred demolished by bulldozers.

But the situation was further complicated by the likelihood that the remains of many of the disappeared had been moved from their original graves into communal graves. By Latin American custom, remains in N.N. graves are transferred after several years to a common depository, usually in an isolated area of the cemetery. This is related to another custom requiring the families or the estate of the deceased to pay a small annual "grave tax." This tax goes toward operating and maintaining the cemetery, but when payments fall into arrears for more than five years, the bones are transferred.

We found other obstacles that the commission faced. Because Argentina traditionally had a low homicide rate, almost all its morgues were poorly equipped and understaffed. Police surgeons and forensic pathologists had little or no experience in identifying skeletons. In addition, although the degree of complicity of individual police surgeons and pathologists was difficult to establish, local human-rights groups had lost confidence in the country's medical and legal systems. Such feelings ran especially deep among the relatives of the disappeared.

Witnesses from the Grave

By 1985, Argentina's search for the disappeared was locked in a race against time. Many medical and dental records had already been discarded, and others were incomplete: more than half the missing were between 20 and 30 years old, an age group that generally receives little medical care. Moreover, most of the disappeared had been buried more than eight years earlier, and hair and clothing were decomposing, erasing vital clues.

To help speed the search, the AAAS in February 1985 sent a second group of forensic scientists to Argentina. At the medical school of the University of Buenos Aires, we conducted a five-week workshop on identifying human skeletal remains. It was attended by 20 Argentines, ranging from undergraduate medical and anthropology students to professional forensic scientists.

Using the remains of actual disappeared, the class learned the techniques of forensic anthropology, odontology, radiology, and pathology. As a final examination, each team prepared a case report, which the AAAS faculty and fellow students critiqued. The teams then submitted the written reports to the courts that had requested the exhumations.

The case of Liliana Carmen Pereyra illustrates the difficulty of identifying the victims of the military dictatorship. A Navy death squad abducted Pereyra, a 21-year-old bank employee, from her apartment on the night of October 5, 1977. She was five months pregnant. The reason for her disappearance is unknown, but a friend kidnapped with her is thought to have belonged to an organization of non-violent student activists. Ten months later, police notified Pereyra's family that she had been killed on July 15, 1978. According to the official account, she met her fate as part of a band of armed terrorists that had attacked a military post.

In 1983, after the military left power, Pereyra's mother began pursuing her daughter's fate by checking the burial records of "El Parque" cemetery, near the town of the Mar del Plata. She came across an N.N. entry that gave a physical description similar to that of her daughter's. She then requested the courts to order an exhumation of that grave.

Meanwhile, two former prisoners had told human-rights investigators that they had been detained with Pereyra between November 1977 and February 1978 in a Navy facility in Buenos Aires. In early February, the women said, Pereyra had given birth in the center's clinic to a healthy baby boy. One of the women, obstetrician Sara Solar Osatinski, said she had assisted a Navy doctor in the delivery. According to both witnesses, Pereyra was transferred back to the detention center without her baby after a day or two. The next day, two members of naval intelligence, who identified themselves as Hector Favre and Pedro Bolita, took the baby away.

More than seven years later, in March 1985, the workshop trainees traveled to Mar del Plata and excavated the grave Pereyra's mother had located. Using a standard archaeological technique, they dropped a test probe at the foot of the grave to determine the level of the burial. With this established, grave diggers used picks and shovels to remove dirt to a level 10 centimeters above the skeleton.

Using the remains of actual disappeared, the class studied forensic anthropology, odontology, radiology, and pathology.

The trainees then resumed their work. With trowels, brushes, and small digging tools, they removed pieces of the disintegrating coffin and then carefully uncovered each bone until the entire skeleton was exposed. They photographed the remains and passed the earth from the grave through screens to recover small items. By mid-afternoon, the pelvic bones had been uncovered, and we could determine that the skeleton belonged to a young female. In addition, the skeleton matched the age, stature, race, and handedness in Pereyra's medical records. Hair recovered from the grave matched hers in length, color, and form.

While these general traits narrowed the possibilities, they were not enough to positively identify the skeleton. Lowell Levine, a forensic odontologist from New York, uncovered a vital link. According to her mother, Pereyra had no fillings or other dental restorations, but a dentist had extracted her upper left incisor shortly before her disappearance. Levine found that the same tooth was missing from the skeleton's otherwise perfect set of teeth. Skull x-rays also revealed an unerupted permanent canine at the same position, a relatively rare dental finding.

The microfilm of a chest x-ray taken of Pereyra about two years before her disappearance strengthened the identification even further. Under the supervision of Chicago radiologist John Fitzpatrick, the microfilm was enlarged, while the workshop participants, assisted by Chicago forensic pathologist Robert H. Kirschner, glued the bones of the skeleton's upper thorax and rib cage together. Comparing the film with the reassembled thorax allowed Fitzpatrick to state that the bones were Pereyra's.

The skeleton also contained evidence of the cause of death. When the 27 cranial fragments were reassembled, they revealed a 5.5-centimeter hole. From the size





FORENSIC ANTHROPOLOGIST CLYDE SNOW AND RADIOLOGIST JOHN FITZPATRICK EXAMINE A CHEST X-RAY TAKEN OF LILIANA PEREYRA BEFORE SHE WAS KIDNAPPED. TO THE TRAINED EYE, CERTAIN FEATURES IN CHEST X-RAYS CAN ESTABLISH IDENTITY. IN THIS CASE, THE X-RAY MATCHES ONE OF A SPINAL COLUMN RECONSTRUCTED FROM BONES FOUND IN A GRAVE NEAR THE TOWN OF MAR DEL PLATA.

PHOTOS: AAAS

Under the dictatorship in Argentina, the military often kidnapped the children of the disappeared.

of the wound and the fact that the pellets had become lodged in the head, we inferred that a shotgun blast fired at a range of about one to three meters had killed Pereyra. Argentine sportsmen seldom use shotgun loads of this size, but the U.S.-based Ithaca Gun Company's 12-gauge pump, with each shell carrying nine "00" pellets, is a standard weapon used by the Argentine police and military.

A final and rather poignant piece of evidence was in the preauricular sulcus, a grove located immediately in front of the sacroiliac joint of the hip bone. This grove widens and deepens during pregnancy, and the presence of such changes in the skeleton showed that the victim had given birth before she was murdered.

Clyde Snow presented the forensic findings in Pereyra's case at the trial of Argentina's nine former military leaders in April 1985. Such expert testimony provides the courts with objective and scientific evidence critical to convicting those responsible for the deaths of the disappeared. From a humanitarian point of view, the identification of the missing also means that families will finally know the fate of their loved ones and be able to give them a proper burial. In addition, the knowledge that litigation and forensic documentation can hold governments accountable for their actions may help deter state-sponsored killings in the future.

The Grandmothers of the Plaza de Mayo

What happened to Liliana Pereyra's baby? An especially tragic aspect of Argentina's disappearances is that the military often kidnapped the children of the disap-



ABOVE: A MEMBER OF THE ARGENTINE FORENSIC ANTHROPOLOGY TEAM USES A SMALL BRUSH TO EXPOSE A SKELETON BEFORE IT IS PHOTOGRAPHED AND CAREFULLY REMOVED FROM THE GRAVE.



RIGHT: A JUDGE'S CLERK TAKES NOTES DURING AN EXHUMATION IN AN ARGENTINE CEMETERY.

PHOTO: CLYDE SNOW



peared. So far, 196 cases have been documented, and Argentine human-rights organizations estimate that about 400 may have occurred. Of the documented cases, about two-thirds were children of women who had given birth in detention before being killed. In the remaining cases, children were abducted with their mothers. Soldiers and police officers claimed some children for their own families as "war booty," and left others in orphanages or gave them to civilians.

Beginning in the late 1970s, some women joined together to search for their missing grandchildren. Their organization, the Grandmothers of the Plaza de Mayo, operates from a small office in downtown Buenos Aires. Hope has turned these women into veritable detectives. Over the years, they have painstakingly examined thousands of pages of public documents, conducted stakeouts, and even gone undercover in their search for clues.

In 1983, reading press accounts of recent advances in human genetics, the Grandmothers wondered if such scientific techniques might be able to link children suspected of being kidnap victims with their biological families. The question eventually reached the AAAS, which relayed it to Mary-Claire King, a human geneticist from the University of California at Berkeley. As the Grandmothers had hoped, King replied that thanks to the numerous and highly specific "genetic markers" available today—including blood groups, red-cell enzymes, and plasma proteins—grandpaternity can be determined with a high degree of confidence.

The procedure is straightforward. Small blood samples are taken from the individuals who might be related. The cells of the adults and the child are tested for matching genetic markers. When certain markers match, scientists can say how likely it is that the adults and the child are related. The most reliable system for this analysis uses proteins called histocompatibility antigens (HLA), which are found in white blood cells.

Traveling to Argentina with the first AAAS delegation, King met with Ana Maria Di Lonardo, a geneticist at the Durand Hospital in Buenos Aires. Together they and French researchers developed an HLA-based test for grandpaternity. To date, the Grandmothers have located 43 children—four were dead and 39 were living with new parents. In at least 12 of these cases, genetic evidence presented to the courts has been critical in identifying children and matching them with their biological families.

If it can be shown that the child was taken by military or police families who knew about the death of the parents, the child is returned to the biological grandparents. If parents adopted a child in good faith and were unaware that its mother was among the disappeared, the courts generally allow it to remain with its new family and grant the biological grandparents visitation rights. Pereyra's child, who would now be about 10 years old, has not been found.

What Could We Do?

Today, six young scientists and medical students, four of whom participated in the 1985 workshop, continue the effort to identify Argentina's disappeared. In 1986, they established themselves as the Argentine Forensic Anthropology Team—*Equipo Argentino de Antropología Forense* (EAAF). So far, the team members, as court-appointed experts, have excavated over 100 graves and identified the remains of 25 people.

Early in 1988, the EAAF began excavating what may prove to be the largest mass grave of the disappeared in Argentina. Actually some 12 to 15 separate graves, each containing up to 20 skeletons, it is located in a secluded corner of one of the largest cemeteries in the Buenos Aires area. By October, the team had excavated nearly a quarter of the surface and exposed about 60 bodies. With the aid of relatives of the disappeared, they have begun tracking down dental and medical records. Armed with this evidence, the team will soon begin the slow process of piecing together the identities of the deceased.

EAAF's work in Argentina has sparked similar expert investigations in El Salvador and the Philippines. In December 1986, for instance, the AAAS sent two EAAF members, along with a Danish forensic pathologist and two U.S. specialists, to Manila to conduct a two-week workshop on applying forensic sciences to human-rights investigations. At the time, families were searching for the graves of over 650 people who had disappeared between 1970 and 1985.

That it took the downfall of President Ferdinand Marcos to spur that effort points to the dilemma for forensic science. Because the field rests on the concept of a legitimate government authority, forensic scientists may face a distressful and dangerous situation when the state itself subverts the system of justice. Aside from the few whose political sympathies led to their actual collaboration with the regime, most Argentine police surgeons and pathologists had agonizing choices to make. As one Argentine pathologist asked the AAAS scientists in 1984: "What could we do? Some of us had

Excellence.
Time after time.



National forensic societies can do much to help scientists investigate alleged human-rights violations.

families. And who could we have turned to for help? If we had protested, we too would have been detained and probably killed."

His first question cannot be answered smugly by those of us who are fortunate enough to work in countries where the rule of law prevails. Faced with pressures to compromise ourselves ethically, we can turn to professional ethics committees, to courts, or to the press. In circumstances such as those that forensic scientists faced in Argentina, we might be inclined to act differently.

Perhaps the best way to answer the first question is to answer the second: "Who could we turn to for help?" The world community of forensic scientists, while small, has a long and respected tradition of bringing scientific knowledge and expertise to the service of justice. The profession has defended human rights for well over a century in laboratories and autopsy rooms throughout the world. The question for forensic scientists is how they can support colleagues who defend human rights by exposing the actions of criminal states.

In this regard, organizations such as the International Association of Forensic Sciences (IAFS) could play an important role. Drawing on its worldwide membership, the IAFS could appoint a professional representative in each country to conduct independent autopsies or serve as an observer when official cover-ups of torture deaths or killings are suspected. In addition, the IAFS could send international delegations to countries where human-rights abuses are occurring, in order to help document such crimes. Governments may deny the delegations entry, but the very act of requesting a visit will put repressive regimes on notice that forensic scientists worldwide are concerned about human rights, the safety of their colleagues, and the integrity of their profession.

Movement in this direction is under way. Since 1984, 45 forensic scientists from 16 countries have joined together in the Committee of Concerned Forensic Scientists and Physicians (CCFS). Some joined the committee after training human-rights investigators in Argentina and the Philippines. Others joined because their own experiences had convinced them of the need to develop international guidelines for investigating suspicious deaths of people held in official custody. Working with the Minnesota Lawyers International Human Rights Committee, CCFS members have helped draft such guidelines, which they are encouraging national and international scientific and human-rights organizations to adopt.

There is also much that national forensic societies can do to help scientists investigate alleged human-rights violations impartially and to ensure that results are openly reported. For example, the societies could promote legislation aimed at creating independent commissions empowered to investigate well-founded allegations of violations of human rights. Such commissions should be furnished with proper laboratory facilities and qualified staff. They should also be empowered, when necessary, to bring in outside experts sponsored by international organizations, such as the CCFS or Amnesty International.

To be sure, forensic scientists alone will not stop the torture and deaths of all the world's Liliana Pereyras. Even so, tradition has vested the profession with a solemn authority to speak for such victims. Implicit in that is a responsibility to speak impartially and truthfully. The dead cannot perjure themselves; only human failure to listen and interpret the evidence can dishonor their final testament. ■



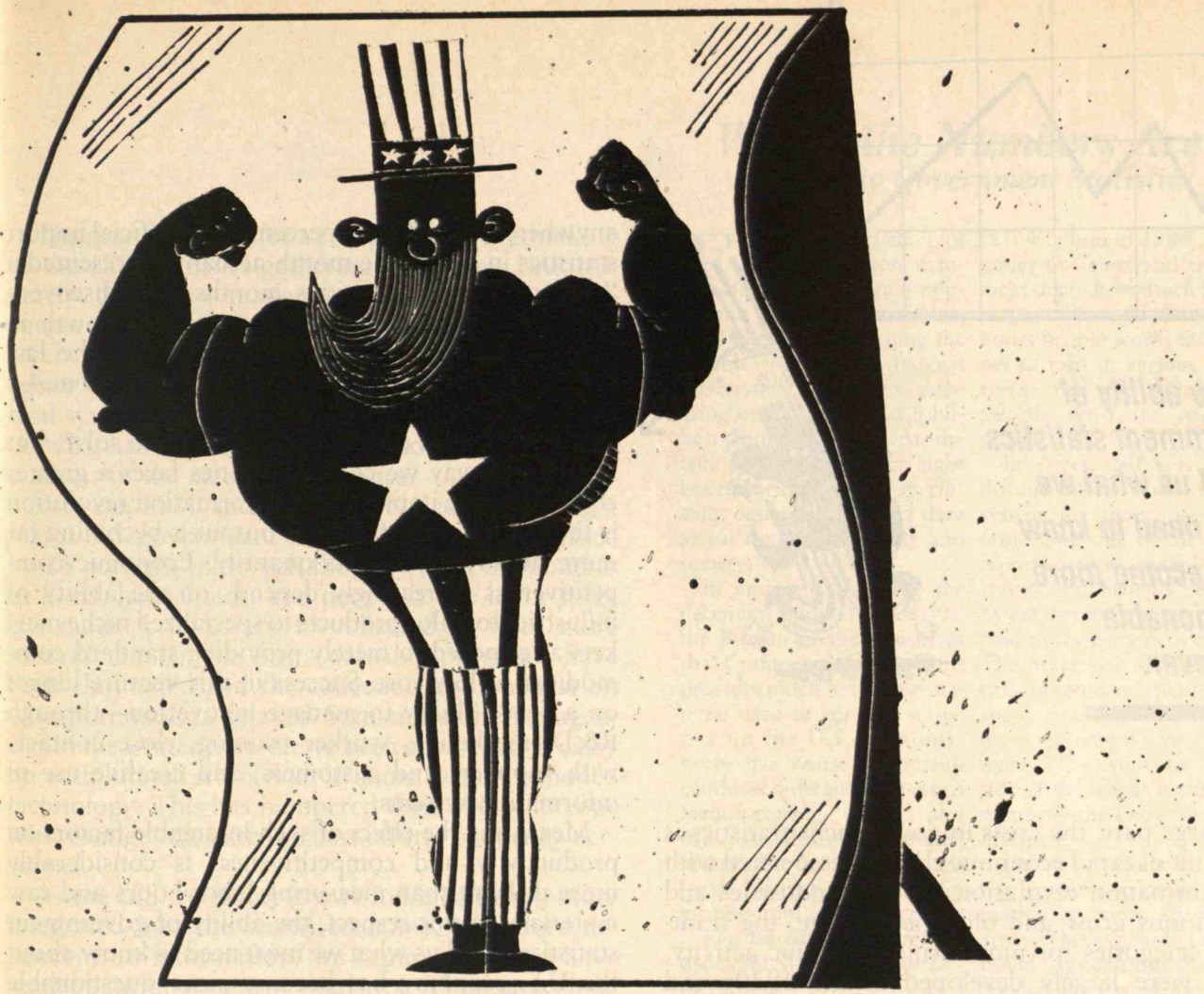
IN 1986, WITH THE HELP OF CLYDE SNOW (THIRD FROM RIGHT), THESE YOUNG RESEARCHERS ESTABLISHED THEMSELVES AS THE ARGENTINE FORENSIC ANTHROPOLOGY TEAM. THEIR WORK HAS SPURRED SIMILAR EXPERT INVESTIGATIONS IN EL SALVADOR AND THE PHILIPPINES.



DISTORTED IMAGE

HOW GOVERNMENT STATISTICS MISREPRESENT THE ECONOMY

BY HENRY KELLY AND ANDREW WYCKOFF

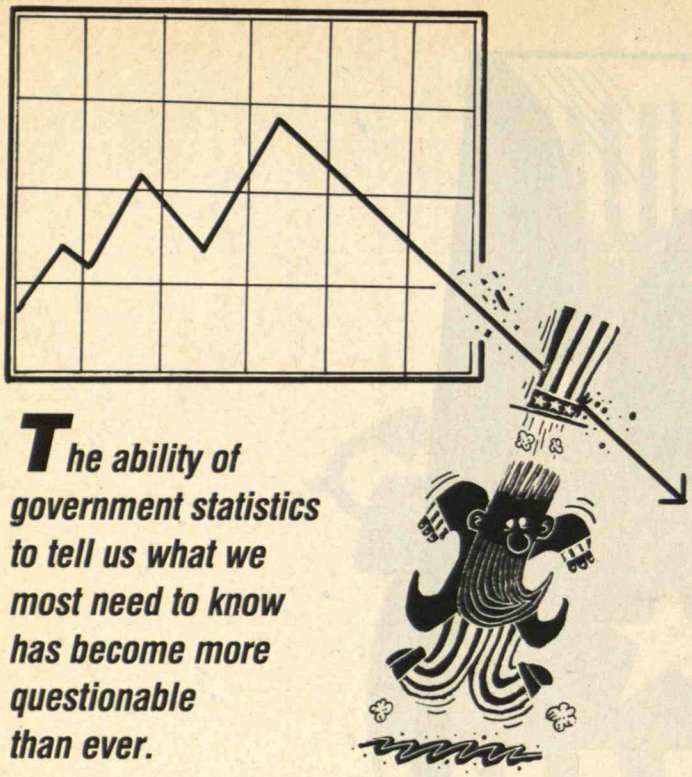


FEDERAL transfer payments are indexed to them. The stock exchange rises or falls by them. Politicians and business leaders make decisions based on them. Government statistics are at the center of our information-based economy.

But the federal government faces a crisis in the way it collects, analyzes, and disseminates information. Paradoxically, at the very moment new information technologies are transforming the U.S. economy, we are forced to rely on data that are often outmoded and outright misleading. Our ability to form a realistic picture of what's happening to the economy and to our society is getting worse rather than better. And this is making it more difficult to make good public policies and business decisions.

Rapid economic and technological change is causing a crisis in government statistics. We can't build an information economy on bad information.

ILLUSTRATIONS: JONATHAN SCHNEIDER



The ability of government statistics to tell us what we most need to know has become more questionable than ever.

In large part, the crisis in government statistics is the result of rapid economic changes associated with the information revolution. As new industries and occupations grow and old ones decline, the traditional categories for monitoring economic activity, which were largely developed in the 1930s and 1940s, are becoming obsolete. For example, the Occupational Employment Survey, produced by the Bureau of Labor Statistics, can tell you how many "railroad brake, signal, and switch operators" there are in the country—42,000 in 1986—but counts more than 3.2 million workers in many diverse service-sector occupations under the traditional heading "secretary." In the absence of new, more relevant categories, the contours of the new economy remain vague and distorted.

As the economy changes more rapidly, mechanisms for acquiring those data that the government does collect are sometimes overwhelmed. For instance, in the mid-1980s the drastic increase in imports made it impossible for the government to collect accurate monthly trade statistics. So much time was required to process trade data that in 1985 anywhere from 35 to 53 percent of the official import statistics in any single month actually represented a "carryover" from previous months. The discovery of one carryover forced the estimate of growth in the gross national product (GNP) during the last quarter of 1984 to be revised downward—from 4.3 to 0.6 percent.

Such problems can be relatively easy to solve, but the current way we collect statistics faces a greater challenge. One impact of the information revolution is that the quality of a firm's output is becoming far more important than its quantity. Economic competitiveness increasingly depends on the ability of industries to tailor products to specialized niche markets as opposed to merely providing standard commodities at low cost. Success in this venture hinges on a firm's ability to manage innovation—through R&D, marketing, worker training, close contacts with suppliers and customers, and creative use of information systems.

Measuring the effect of such intangible factors on productivity and competitiveness is considerably more difficult than measuring labor hours and raw materials. In this respect, the ability of government statistics to tell us what we most need to know about the U.S. economy has become more questionable than ever before.

Incomplete or inaccurate statistics are costly. Every month, the Bureau of Labor Statistics publishes the Consumer Price Index, which estimates inflation by regularly surveying prices for a predetermined "market basket" of consumer goods. The wages of at least 8.5 million workers in the private sector and the payments made to 38 million Social Security recipients are linked to changes in the index. According to one estimate, an error of one percent in the cost-of-living adjustment derived from the Consumer Price Index could add over $4 billion to the federal budget.

Even more important, bad statistics can lead to bad policy. Government data are a vital window on reality—and, at times, the only one—for the Congress, federal executive agencies, state governments, and many private firms. Is the trade deficit getting better or worse? Is U.S. productivity lagging and, if so, why? Are the billions of dollars we spend every year on health care actually resulting in better health? Effectively addressing such questions depends on data that only public statistical organizations can provide.

HENRY KELLY is a senior associate at the Office of Technology Assessment (OTA) and was project director of the OTA assessment Technology and the American Economic Transition: Choices for the Future, *on which this article is based. ANDREW WYCKOFF is an analyst at the OTA and was a major contributor to the economic-transition study. The views expressed here are solely the authors' and do not necessarily reflect those of the OTA.*

The time has come for a comprehensive rethinking of the U.S. statistics-gathering operation. Unfortunately, the task is made more difficult by the inadequate resources given to U.S. statistics agencies in recent years. Another problem is that the executive agency responsible for overseeing the entire statistical system, the Office of Management and Budget (OMB), has failed to effectively coordinate the operations of the statistical agencies.

Between 1980 and 1988, the budgets of the eight major U.S. government statistical agencies decreased by 13 percent—although the growth in the number of firms, households, and people in the labor force has made it necessary to collect data from more sources than in the past. Valuable programs have been eliminated and the collection and publication of important data delayed. Statistics-gathering agencies in the United States have been compelled to carry on with limited staffs and, in some cases, outmoded technology. This has hampered their ability to cope with change—despite the best efforts of agency personnel.

As the U.S. economy grows more complex, more integrated into the world economy, and more dependent on information, we cannot afford to have inadequate government statistics. That fact alone justifies increased attention to and investment in our statistics-gathering system. Modernized and more efficiently managed data collection might actually deliver more timely and more relevant data at a lower cost as well.

Faulty Assumptions

Government statistics are only as good as the assumptions on which they are based. Some faulty assumptions have been part of the statistics system for decades. A classic example concerns how the national accounts define government investment.

In private industry, it is standard accounting practice to divide a firm's outlays into long-term "investment" in new plants and equipment and short-term "current expenses"—wages, salaries, and the cost of supplies. National statistics honor this distinction for private-sector businesses but not for government spending. This means that, for example, money spent on highways—roughly 10 percent of all spending by state and local governments—is not counted as an investment, even though those highways will probably last many years. Government

Where the Numbers Are:
A Guide to Government Statistics

Ever since Article I of the Constitution mandated a decennial population census, statistics have been central to governing the nation. Today, the federal government's statistics-gathering operation is a $1.6 billion annual activity. At the core of this system are eight government agencies specifically designed to collect data about the U.S. economy and society.

In addition to taking the decennial population census, the **Bureau of the Census** in the Commerce Department provides much of the raw material used to compile statistics on the U.S. economy. Every five years, the bureau conducts a detailed census of manufacturing, service, and other business establishments. The bureau also collects household data on incomes and employment.

The **Bureau of Labor Statistics** (BLS) in the Labor Department collects and analyzes data on employment and unemployment, hours of work, wages, productivity, and consumer and producer prices.

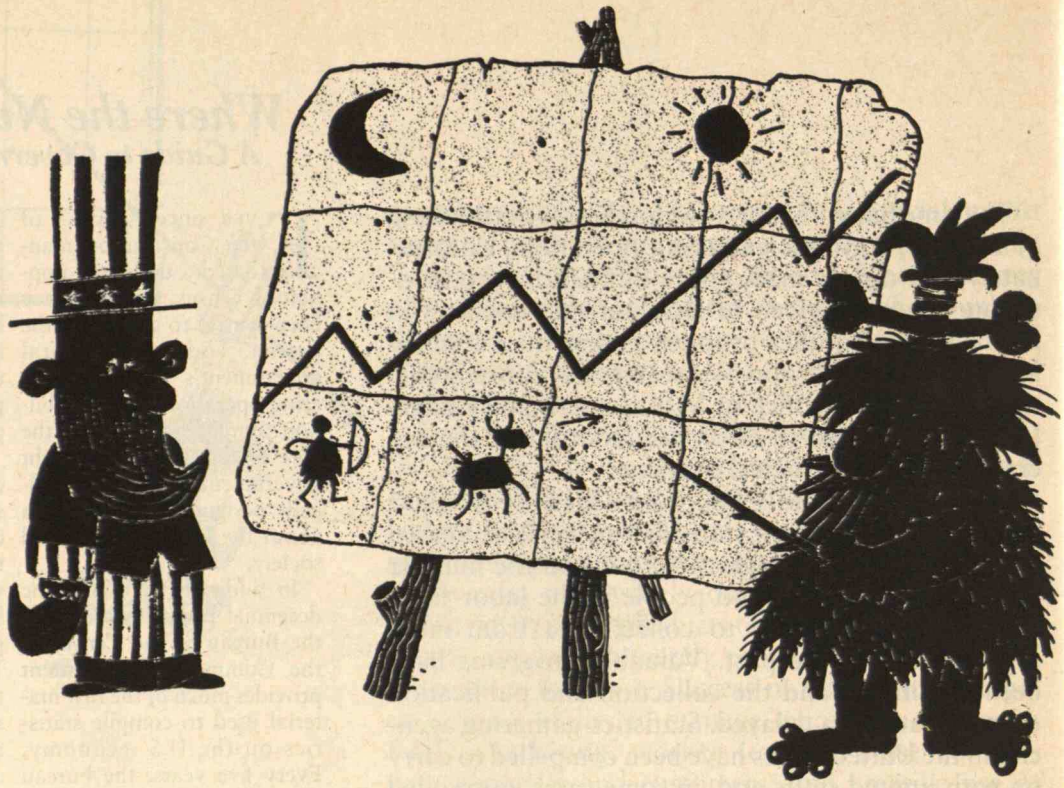
The **Bureau of Economic Analysis** (BEA) in the Commerce Department provides data on aggregate economic activity and creates input-output tables for 537 industries in the economy. The format for most economic statistics compiled by BEA dates from 1929, when data began to be reported in a unified series known as the National Income and Product Accounts (NIPA). NIPA consists of about 130 different tables, each representing a different facet of the U.S. economy. NIPA tables on consumer spending can tell you how much U.S. consumers spend on funerals ($7.1 billion in 1987)and food eaten away from home ($164 billion in 1987). NIPA tables on labor and employment detail how much money is spent on wages, how many hours people work, the number of jobs in various industries, and the number of people who are self-employed.

In effect, NIPA is like a double-entry bookkeeping system for the entire economy. One side of the ledger reports income, including the wages and benefits received by employees and the returns paid to the owners of capital. The other side shows where this income is spent—personal consumption, government programs, or investment. The sum on either side of the ledger is the same number—the Gross National Product.

Other government statistics agencies compile information in more specialized areas. These include the **National Agricultural Statistics Service**, the **Center for Statistics** of the Education Department, the **Energy Information Administration**, the **National Center for Health Statistics**, and the **Bureau of Justice Statistics**.

In addition to the statistics agencies, some 70 other government departments and offices such as the Department of Defense, the Environmental Protection Agency, and the National Highway Traffic Safety Administration collect vast quantities of "administrative data," used to carry out specific regulatory or other programs. Although often collected for narrow purposes, the data are useful supplements to the information provided by the statistics agencies. However, with the dismantling of government programs caused by deregulation, many of these valuable administrative-data series have been discontinued. ■

It takes so long to create some statistics that by the time they are published, they no longer accurately reflect reality.



spending on research and development—about $60 billion per year—is treated the same way.

This curious practice creates problems in tracking spending in the economy. Because government investments are excluded by definition, figures on net investment are regularly underestimated. And no provision is made to cover the depreciation of crumbling roads, sewers, and schools. Finally and perhaps most important, the government's growing role as an investor in the economy's infrastructure is obscured—so that government spending is seen as unnecessary or illegitimate. According to one estimate, nearly two-thirds of the roughly $150 billion annual federal deficit is in categories that qualify as useful capital investments.

Other assumptions were reasonable when they were first made but have become obsolete as a result of economic change. Consider how we treat both public and private spending on education and training—which amounts to roughly $300 billion to $500 billion each year, more than the net private purchases of equipment like machine tools and computers. As the economy becomes more complex and advanced technologies play a more central role, education and training begin to represent a crucial investment. Yet government statistics treat spending on the intellectual capabilities of the work force no differently than spending on candy bars. The data suggest that a company is investing if it purchases a new machine, but not if it pays for the employee training needed to use that machine efficiently.

Obviously, some assumptions have to be made about which education outlays qualify as investment and which do not. However, even the most conservative estimates would more accurately reflect the new realities of an education-based economy.

Sometimes the assumptions incorporated in government statistics are highly technical; nevertheless, they can have broad policy implications. For example, policymakers and economists have recently expressed great concern that service-sector productivity appears to be stagnant despite massive investments in capital equipment like computers. But the sluggishness may actually reflect inadequate statistical methods.

Unlike manufacturing industries, the services generate an output that is extremely difficult to measure, so in some service industries such as banking, government statisticians estimate output by looking at the number of employee hours in a particular year. The more workers, the higher the output is presumed to be. The problem is that labor productivity in the service sector, as in other industries, is typically calculated by dividing total output by the total number

of hours needed to generate it. Since the number of hours has already been used to estimate the amount of output in the first place, this puts hours in both the numerator and the denominator of the ratio, canceling one another out. The result is that productivity increases are eliminated by definition.

Falling Behind Change

Rapid economic and technological change highlights other weaknesses in our statistical system. It takes so long to create some statistical series that by the time the data are published, they no longer accurately reflect reality.

One of the most important mechanisms for describing the economy goes by the name of the "input-output" table. Created for 537 different industries, the tables show what kind and how much of each particular input is necessary to produce a given amount of output in a given industry. For example, according to the most recent input-output table for the automobile industry, $100 worth of cars requires $6.14 worth of steel, $3.44 of rubber, $22.66 of labor, and $8.78 for payments to holders of capital, and $58.98 for other inputs.

In effect, input-output tables are a snapshot of the production relationships among all the sectors of the U.S. economy. They describe how raw materials, purchased goods and services, capital, and labor come together to produce what Americans consume.

Input-output tables have always been important because they are the starting point for so many other sets of data. The Bureau of Labor Statistics relies on input-output data to calculate such widely followed statistics as the producer's price index—an important indicator of inflation—and estimates of what occupations will be in demand in the future. The Department of Defense uses input-output to analyze how to mobilize the economy in the event of war. Input-output is at the heart of the Department of Agriculture's projections of agricultural output and the Department of Energy's estimates of energy use. The tables even play a role in the calculation of GNP.

But there is good reason to believe that input-output tables are becoming even more important as the economy changes. As new technologies penetrate U.S. industry and international trade makes foreign components a central element in production, the relationships among industries are rapidly changing. Input-output tables are a potential tool to chart that transformation. Unfortunately, the U.S. government's tables are woefully out of date. Those now in use, published in 1984, are based on information collected by the Census Bureau in 1977.

Creating the tables *is* a cumbersome process. Every five years, the Census Bureau conducts a comprehensive census of American business. The information is then transferred to the Bureau of Economic Analysis (BEA), which uses it to create the 537-industry "benchmark" input-output tables. And that's where the trouble begins.

Until 1985, the Census Bureau delivered the massive amounts of data to the BEA on paper. Every number had to be reentered by hand and checked and rechecked. Recently, the Census Bureau has started to deliver its data on computer tapes, but the tapes are simply a digital representation of the pages. The tables appear with lines, headings, notes, and page numbers, which still have to be removed in a laborious, time-consuming process.

The BEA does try to update its tables every year to keep track of changing industry relations. But these updates have problems of their own. First, the original 537 industry categories are combined into only 85 industrial sectors. And these heavily favor traditional manufacturing industries rather than the fast-growing new service industries. For example, the updates provide excruciating detail on the production of wooden boxes—an activity that accounts for about .02 percent of GNP—while the entire private health, education, and social-services industries, about 8 percent of GNP, are lumped into a single category. The annual updates are also based on far less comprehensive data than the five-year benchmarks.

The input-output backlog will not be resolved anytime soon. A new input-output benchmark, based on 1982 census data, won't be released until 1989. And if we keep to this same schedule, the most recent data, collected by the Census Bureau in 1987, won't be available in the form of input-output tables until 1994.

Such delays seriously skew our understanding of the economy. For example, when the Commerce Department finally shifted from the 1972 to the 1977 input-output tables and incorporated a number of other statistical adjustments, researchers discovered that the original calculation of the 1983 GNP was

Modernization of government statistics must begin with managerial reform.

low by $100 billion—the equivalent of a whole year's worth of strong economic growth.

In an era when computers are easier to use and vastly more powerful, delays in creating input-output tables should be growing shorter, not longer. Other nations manage to produce detailed input-output data much faster than we do. Japan already has input-output tables based on data collected in 1985. And the Japanese government has recently proposed creating an input-output model for a major portion of the international economy.

As we strive to produce input-output tables faster, we should, again, take care to weed out assumptions that are no longer valid. For instance, there are hundreds of categories for raw materials and component products in the tables, but although today's jobs require widely varying levels of skill there is still only one category for labor.

One way to measure the quality of labor inputs would be to consider the presence of various occupations in an industry. This would permit statisticians to calculate the productivity of different occupations, not just the productivity of a mixed bag of "work hours" invested. The information could also be used to trace the value added by skills throughout the economy.

Another problem is that the tables do not separate domestic inputs to U.S. business from foreign ones. The distinction may not have mattered when most components of products manufactured by U.S. firms were made in this country. But in today's international economy, it is important to understand the role played by foreign goods and services in U.S. production, something that is impossible to determine from current input-output tables.

Poor Coordination and Unnecessary Duplication

The poorly coordinated structure of our statistical system represents a different kind of obstacle. Many agencies collect large amounts of information for their own purposes, and over the years, they have compiled data in categories that do not quite correspond to each other.

For example, numbers on U.S. food consumption available from the Department of Agriculture are significantly different from those that appear in the National Income and Product Accounts, produced by the BEA. While both series track the amount of money spent on food eaten away from home—now roughly 33 percent of all spending on food, according to the BEA's figures—each agency defines it differently.

Inconsistent definitions also plague the information collected by different agencies of the Commerce and Labor departments. The Census Bureau's "enterprise statistics" list U.S. manufacturing industries according to 140 sectoral categories. The corresponding BEA list, however, has about 300 categories. Meanwhile, manufacturing industry output is reported in the National Income and Product Accounts in 21 categories. And the Bureau of Labor Statistics uses yet another set of industry categories, 119 in number, for its own "employment and output" series.

Finally, because it takes BEA so long to prepare its benchmark input-output tables, agencies like the Bureau of Labor Statistics create their own tables to meet their special needs. These tables rarely correspond to those coming out of BEA.

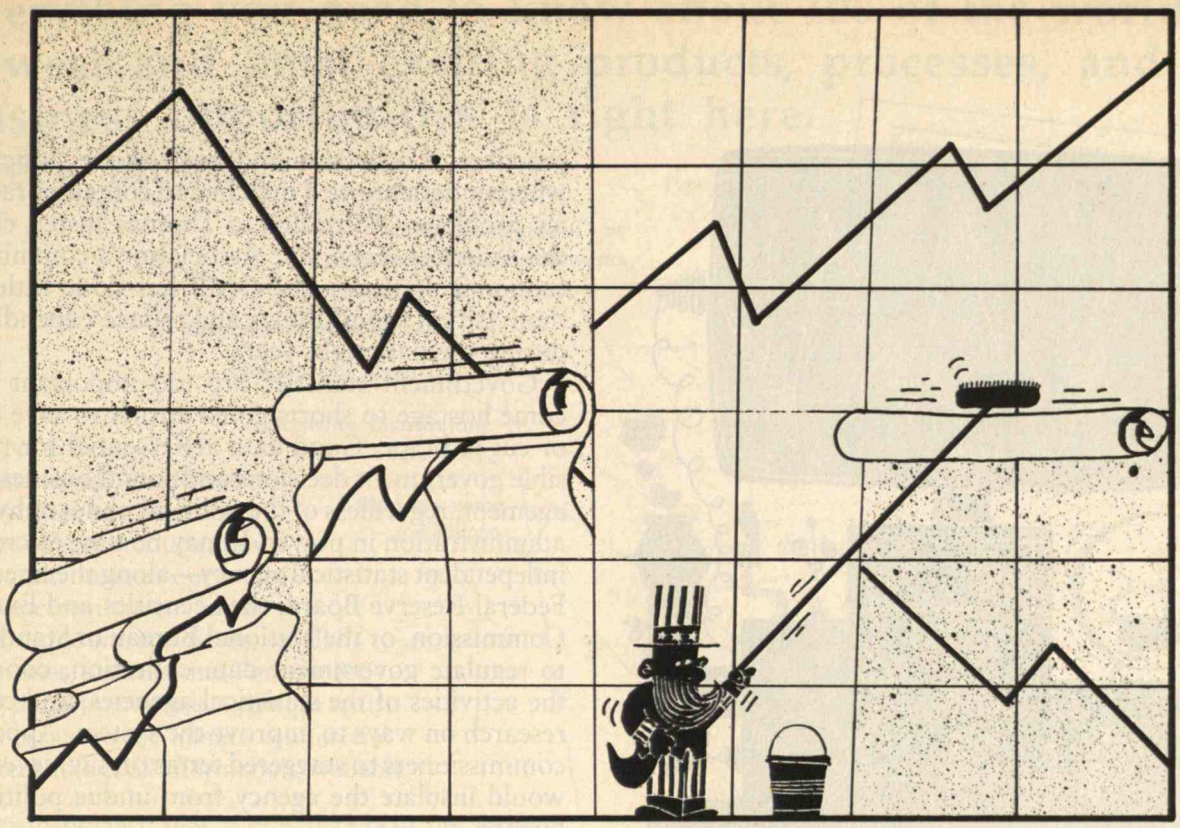
All this confusion means that a large amount of time and effort is spent simply converting one set of classifications to another. And despite diligent efforts, errors continually creep into the system in ways that are difficult to detect.

While some inconsistency is unavoidable in such a complex undertaking, our current system is in need of repair. A combination of better overall management and the use of modern information-processing equipment is a potential solution. For example, one way to speed the production of input-output tables would be to combine the BEA office that creates the tables with the Census Bureau, which collects the original data.

Filling Gaps in the Data

Once the problems with the data we already collect have been resolved, we can begin to ask questions about what new kinds of data we need to collect in the future. What do we want to know about the economy and our society? What kind of information would help us more effectively manage the technological, economic, and social changes we face? Here, the key challenge will be to link statistics about the economy as a whole with more qualitative information about specific socioeconomic groups.

For example, we know how much money people spend on food but little about how many people are hungry or poorly nourished.



We know something about how much the nation as a whole spends on health care but have little information about what individuals in various income and demographic groups spend—let alone how these expenditures correlate with good health.

We know how much we spend on transportation but almost nothing about how those expenditures relate to the duration of our morning commutes and other important indicators of the quality of the nation's transportation system.

The Department of Housing and Urban Development's American Housing Survey—conducted every other year—provides information on how much we spend on housing, but almost nothing about the extent to which affordable housing comes at the price of longer commutes.

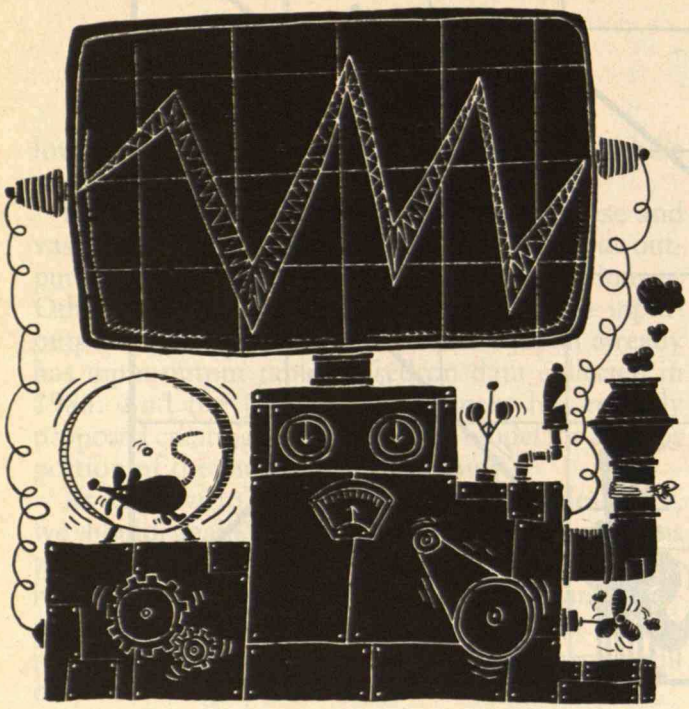
And decades after sociologists heralded the arrival of the leisure society, data on spending patterns for recreation are virtually nonexistent. We know astonishingly little about American leisure habits or the extent to which opportunities for recreation are growing or shrinking for different kinds of households.

One way to address the growing importance of quality in the U.S. economy would be through surveys of how Americans spend their time. "Time use" is becoming a critical factor in economic analysis as major changes occur in the activities formally counted as a part of the market economy. For instance, many activities formerly done during unpaid household time—looking after children, cooking the evening meal, taking care of elderly parents—are now often obtained through economic transactions. In other cases, buying services has been replaced by the purchase of new kinds of capital equipment—for example, the videocassette recorder, which cuts down on the number of trips a family takes to the local movie theater.

Changes in time use provide a good way to assess important qualitative changes in the performance of the national economy not easy to measure in dollars and cents. What's more, we know how to conduct such surveys because we have done so in the past. The National Science Foundation funded small time-use surveys in 1965 and 1975, but budget cuts made a 1985 survey impossible. Fortunately, a private corporation, AT&T, provided funding for a similar time-use study that year based on the same categories as the earlier research, and has recently agreed to make most of the data available to the public. To ensure that the statistical series continues, time-use surveys, conducted at least every five years, should become part of the regular social and demographic data that the U.S. government collects.

Needed: Managerial Reform

Comprehensive modernization of the government's statistics-gathering operations must begin with thorough managerial reform. The 1980 Paperwork Reduction Act, introduced and signed by President Carter, gave the responsibility for oversight of the



New technologies could increase the timeliness of government statistics and reduce the burden on firms.

U.S. statistical system to the Office of Management and Budget. But during the Reagan years, the OMB took an extremely narrow view of its role as caretaker of government statistics and concentrated on one provision of the 1980 law—to reduce the "burden hours" that statistics gathering places on private businesses.

Any time a federal agency wants to collect information from the public, it has to submit the survey to the OMB and estimate how many "burden hours" will be necessary to fill it out. OMB enforces an "information collection budget" that restricts the number of expected burden hours any agency can use.

Limiting the burdens that data collection places on the private sector is a legitimate goal. However, by focusing primarily on the costs rather than the benefits of government statistics, OMB has not done a good job of managing the $1.6 billion federal statistics budget. The agency has not provided a systematic mechanism for evaluating whether current practices of collection and analysis are sufficient or whether data are well matched to contemporary policy problems. According to Thomas Juster, chair of the American Economic Association's committee on economic statistics, the OMB has done little more than "sit on top of things and reduce expenditures" during the past eight years.

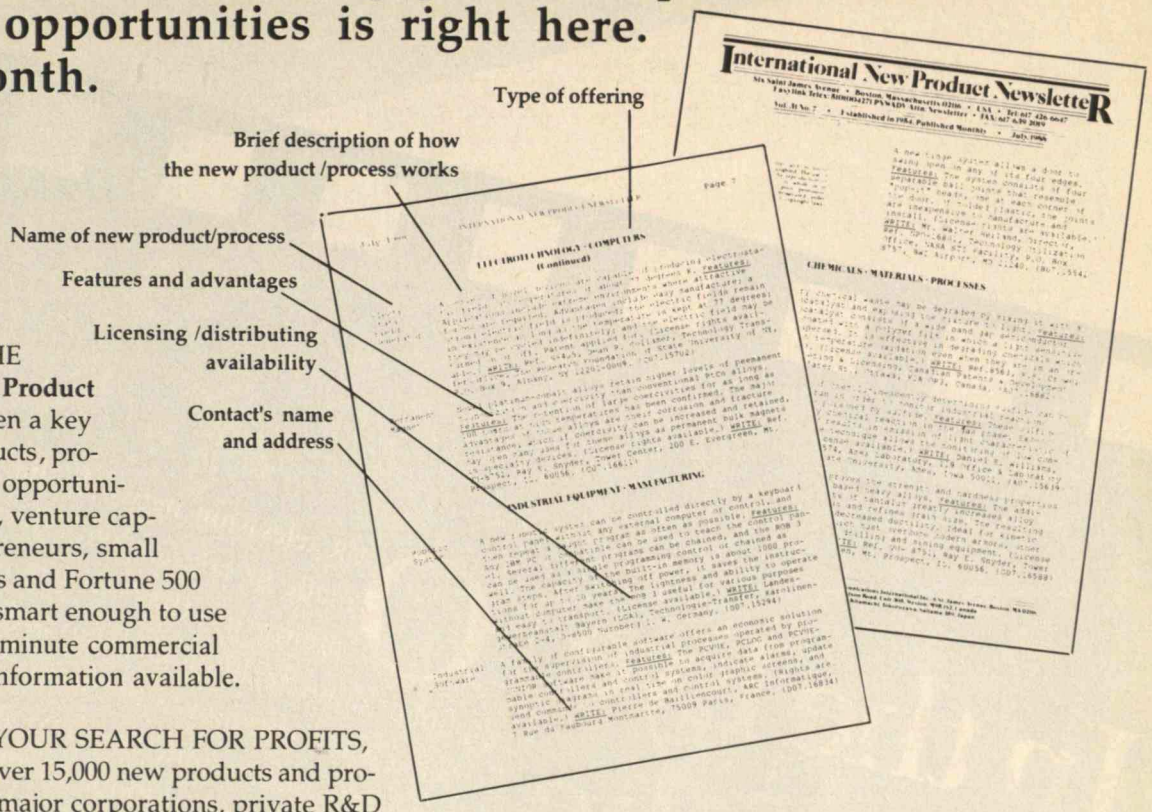
Government statistics are too important to become hostage to shortsighted efforts to save money or cut red tape. Good data are essential for responsible government decisions and sound business management, regardless of the political philosophy of the administration in power. It may be time to create an independent statistical agency—along the lines of the Federal Reserve Board, the Securities and Exchange Commission, or the National Bureau of Standards—to regulate government data collection, coordinate the activities of the statistical agencies, and conduct research on ways to improve the system. Appointing commissioners to staggered terms of, say, seven years would insulate the agency from undue political influence.

Immediate action can be taken to upgrade the technological resources of the major statistical agencies. New computer and communications technologies would make it possible to both increase the timeliness of government statistics and reduce the reporting burden of firms. For example, it should be possible to improve techniques for collecting statistics electronically—possibly by allowing companies to transfer data directly from their accounting software. The IRS now has a pilot program that allows the electronic filing of tax returns. This cuts the IRS processing time by two or three weeks and reduces errors by a factor of 10.

New technologies could also make the dissemination of government data far cheaper. It is not necessary, for instance, to maintain costly publication programs when data can be made available electronically at a much lower cost. A recent General Accounting Office survey of government agencies has revealed that fewer than a third issue data on magnetic tape, fewer than a fifth disseminate information on floppy disks, and only 4 percent make use of an electronic bulletin board.

The realities of the federal budget deficit make expanding any program difficult. However, better information will save money in the long run by improving our ability to evaluate programs and promote economic growth. Without such information, policies naively designed to encourage growth could have precisely the reverse effect, and threats to a just and prosperous American society will go unrecognized. ■

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In the Eye of the Beholder

POETIC DOCUMENTARIES ABOUT TECHNOLOGY

Two West Berlin filmmakers have startling perspectives on the way technology and ideology have meshed in the twentieth century.

BY KAREN ROSENBERG

OUR television networks have made us familiar with documentaries that inform the public about technological inventions. What is less common is the artistic documentary that assumes we have assimilated clichés about technology and tries to expose them. Like most modern art, such films and videos often use shock techniques to disrupt our old patterns of thought. Irony in the narration, strange visual images, and startling juxtapositions in the realm of both sight and sound are hallmarks of this style. Two West Berlin filmmakers in their mid-forties, Hartmut Bitomsky and Harun Farocki, provide good examples of the genre. The fact that they studied and worked together on films in the 1960s and early 1970s may explain their similarities. Their cameras linger on archi-



In his novel documentary *Reichsautobahn,* Hartmut Bitomsky explores the Nazis' methods of influencing people. Their propaganda could be artistically sophisticated, as is clear from this image. Shot from below, it makes highway construction work look heroic and ennobling.

val footage, diagrams, or still photographs not to illustrate a story but to find attitudes toward technology, and their aphoristic commentaries provide a counterpoint to the images. Because Bitomsky and Farocki deliberately eschew smooth, easy-to-follow narrative, these works defy most Americans' expectations of what a documentary is.

Civil Engineering Meets Human Engineering

Bitomsky's *Reichsautobahn* (1986) is not a conventional chronology of the building of the Autobahn, the German highway system that was begun under the Third Reich. Though the documentary starts with Adolf Hitler's inaugural shoveling in September 1933, the mechanics of road construction are not this filmmaker's primary interest. What concern him are the Nazis' methods of human engineering—their ways of influencing people. The German Autobahn demonstrates how a gigantic public-works project was sold to a nation through an intensive propaganda campaign. And to the extent that hard-sell techniques are not a Nazi monopoly, this film is about more than a particular chapter of German history.

Bitomsky transports us to a time when the advantages of a divided highway were conveyed to Germans through simpleminded movies. "Today one would have to think away the Autobahn, we're so used to it," his commentary runs. "Back then it was so unfamiliar that one had to think one's way into it." *Reichsautobahn* shows that what was taught in the Nazi era was not just how to use the new highways but how to see them. Under the Nazis, people had to call them "Adolf Hitler's roads," and apparently even today some Germans believe the Autobahn was one of their former leader's few good ideas. However, as Bitomsky notes, the plan to build roads that would skirt cities and avoid intersections predated Hitler. The Nazis also convinced many Germans that the Autobahn provided employment on a vast scale, yet Bitomsky estimates that the highway and its ancillary industries brought only a small percentage—some 5 percent—off German unemployment lines.

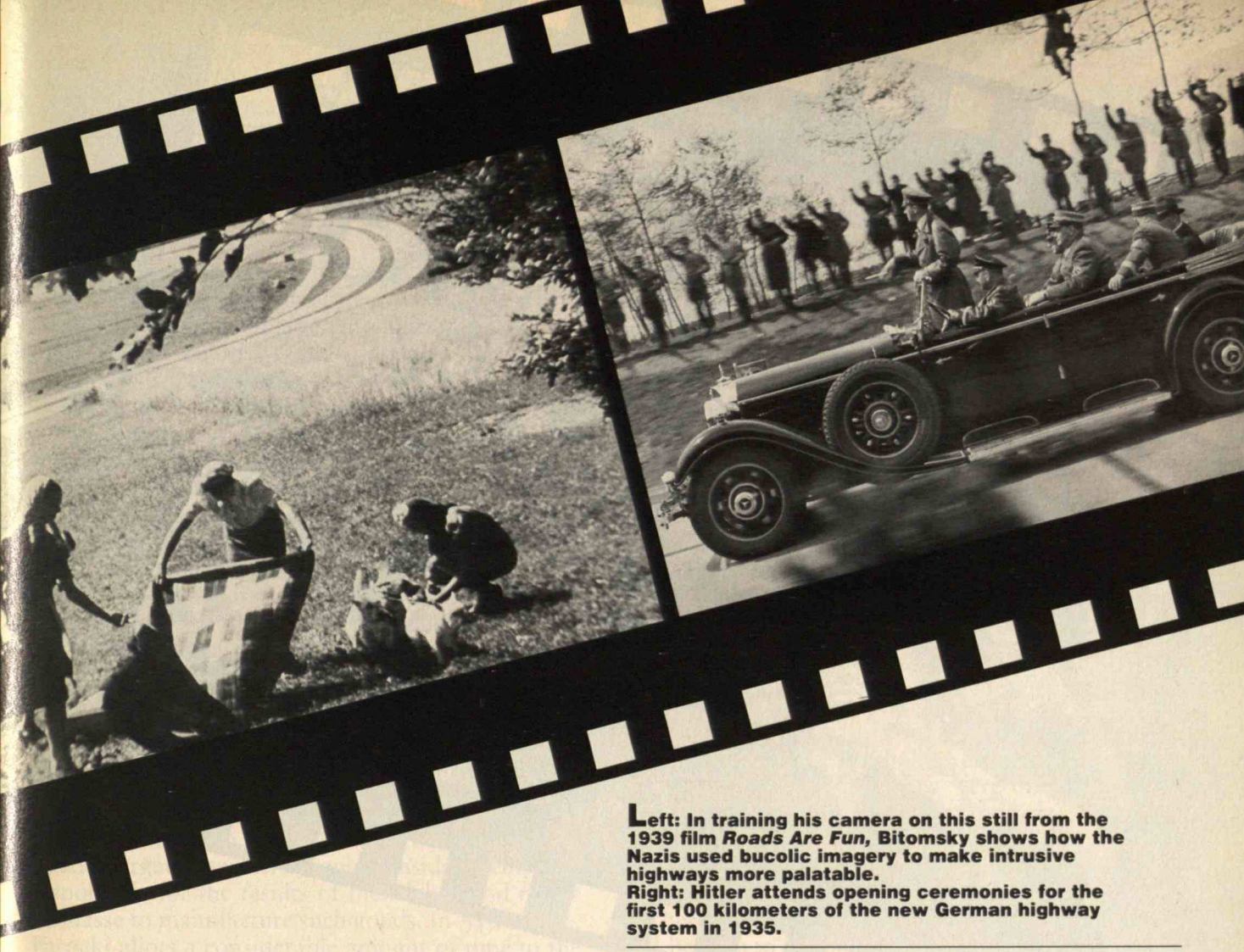
Why was the Autobahn built, then? Not, as another cliché has it, primarily for military use. As a retired engineer tells Bitomsky, the concrete used proved too thin for the heavy trucks that traveled on the roads as of 1937. (Tanks, of course, moved long distances by rail.) The importance of the Autobahn, Bitomsky suggests, was largely symbolic. By joining various parts of Germany, it created the impression of national unity. Bridges—Bitomsky indicates with quotations from the time—were celebrated as signs of German engineering skill. The road system functioned as a gigantic monument to the will and power of the Third Reich. And since the Nazis considered the Autobahn a source of pride, they exploited the scenic line of the roadway for photo opportunities starring Hitler and his troops in attitudes of mutual devotion.

Some of the early shots of the Autobahn conform to the popular notion of Nazi propaganda, featuring soldiers who salute with raised and outstretched arms. But although the Nazis declared war on modern art, they were willing to make use of the dramatic compositions of still photographers and cinematographers who had been influenced by the Weimar-era avant-garde. The images that resulted were insidious because attractive, and they made for an especially effective manipulation of the media. In short, not all pictures of the Autobahn were old-fashioned kitsch: a surprising number reflect aesthetics that are still fashionable today.

Out of the archives Bitomsky brings forth the Autobahn magazine, Autobahn poetry, and Autobahn novels, oratorios, radio plays, paintings, movies, and coffee-table books. The very quantity of paeans to the beauty and usefulness of the Autobahn suggests there was psychological resistance to these roads that carved up the landscape, and indeed it gradually becomes evident that the photographs of peaceful roadside picnics and peasants haying by the new highway were intended to present the fiction of a society where traditional families and traditional agriculture harmonized with modernity. A little cheesecake—young women sunning themselves by the Autobahn—soothed the disruption caused by the new element in the countryside.

However, like most propaganda, the attractive images tended to conceal facts that were disquieting, not just slightly less than idyllic. "One picture answers another" is the poetic, elliptical phrase that Bitomsky employs in *Reichsautobahn* to allude to this phenomenon. The highway system could sym-

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Left: In training his camera on this still from the 1939 film *Roads Are Fun*, Bitomsky shows how the Nazis used bucolic imagery to make intrusive highways more palatable.
Right: Hitler attends opening ceremonies for the first 100 kilometers of the new German highway system in 1935.

bolize the united will of the German people only if class tensions were covered up. So, Bitomsky points out, foremen rarely appear in Autobahn movies and contractors don't exist. Films about happy Autobahn workers, he notes, camouflaged the reality of low wages and work-related accidents. Yet he shows that problems on work sites did appear in some Nazi-era films. For example, on-the-job theft crept into one semi-documentary.

A Car for Everyone

Like a Janus figure, *Reichsautobahn* looks in two directions, back to the past and toward our present. Scattered in the narration are ironic lines suggesting that the filmmaker views the building of the Autobahn as a formative experience for West Germany. "Here begins the attempt to base the national economy upon the car industry," he says. A news clip from 1938 shows Hitler bestowing an award on Ferdinand Porsche. The Volkswagen, Bitomsky remarks, was to be a car for everyone, part of the Nazis' "economic miracle." Today few people are aware that this phrase, made famous in the postwar years, was used by the Nazis in the 1930s, and Bitomsky's pointing out the coincidence has a provocative edge.

The last Autobahn bridge "leads into the American era," says the narration—another charged statement. What Bitomsky is hinting at is a matter of interpretation—many a good artist leaves a great deal to the audience instead of hitting each nail on the head—but the message is clearly nothing simplistic, such as that West Germans and Americans today are the same as the Nazis. Rather, the filmmaker seems to be urging present-day audiences to consider what they share with Nazi-era values. *Reichsautobahn* demonstrates that the ideal the Nazis projected was an affluent society with resources and hours to burn on automobile tourism. It was a dream they couldn't realize, but one that did not die with their defeat.

In the advanced industrial nations, the romance of the road has been sold with advertising techniques that can be considered a form of propaganda. No Luddite, Bitomsky isn't criticizing the automobile per se, which he considers a useful form of transportation, but cultures that fill up leisure time with



Above: Pages from the program for the film *One Man for Another* (1939). According to Bitomsky, the Nazis used the construction of new highways to celebrate German engineering. Josef Goebbels, the Nazi minister of popular enlightenment and propaganda, ordered this fiction feature reshot because a technical failure motivated a crucial part of the drama. In the final version a landslide is the culprit.

elaborate car-related obsessions. His film spawns questions like: Is that the goal we should be setting for human beings? Or: If the cult of the Autobahn appears grotesque now, what will historians of the future say about our road culture?

"It's the aim of modern industry to put as many people as possible in their cars. It's strange to have one-third of the economy—or even more—based on automobile construction," Bitomsky said when I talked to him in West Berlin. *Reichsautobahn* suggests that the prevalence of fantasies about cars and travel may be one response to a lack of fulfillment on the job. "What people do not get in their work life they are given in their private life and spare time. The idea is: Let them see movies, let them stay in their cars," Bitomsky theorized.

Forks in the Road

Filmmaker Harun Farocki also criticizes modern car culture, but in contrast to Bitomsky, he tends to hit nails on their heads. In his 1986 documentary about alternative technologies *As You See* (*Wie Man Sieht*), Farocki states much more explicitly that we have a cult of the road: "Whoever works today spends a third of his working hours and money on cars and roads. Likewise in the Middle Ages people spent a third of their time and means on cathedrals." Like Bitomsky, Farocki trains his camera on old photographs of the Autobahn and points out that bridges sometimes resemble the arches of a church nave. From this, he draws a subjective conclusion: "Above all, it is the bridges which invite devotion to the

road." In the avant-garde tradition, this filmmaker plays the flamboyant provocateur whose role it is to wake up audiences to different values.

Images of the road—and especially of intersections—have an important metaphorical role to play in Farocki's poetic documentary. "The choice between two roads, the forking of ways" is his symbol for past decisions that might have brought us to a different present. "The history of technology is fond of describing the route that developments have taken from A to B. It should describe which alternatives there were and who rejected them," says his narrator. *As You See* is primarily concerned with two technological paths that Farocki believes could be followed: the manufacturing of socially useful products and the development of processes that exercise workers' physical and intellectual abilities.

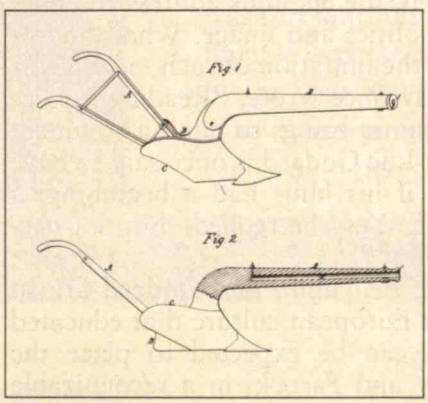
Farocki's vision has been shaped by the historian and social theorist Max Nettlau, who maintained that workers are degraded and hardened by producing goods that are harmful to other human beings. Rather than simply blaming their employers, Nettlau argued, workers should consider themselves responsible for the results of their labor and refuse en masse to manufacture such goods. In *As You See,* Farocki allots a considerable amount of time to the attempt of employees at the British firm Lucas Aerospace to shift production from military goods to socially useful items, including an unusual "bus/train" that can be driven on roads or rails. Because this vehicle can climb very steep grades, it can spare the environment in regions where building conventional roads would require extensive cutting into and tunneling through mountains.

In Farocki's film art, shots of the Lucas plant remind us that swords can be turned into ploughshares. The alternative is represented by still photos of the first tanks, made from farm vehicles, and by a diagram of a bizarre cannon anchored on—yes—a ploughshare. By opposing sequences about the bus/train with the picture of the cannon/plough, the film creates a rhythm of fear and hope.

Farocki repeatedly offers a course of hope that we can choose to follow. He makes it clear that workers' physical and intellectual abilities do not have to become moribund—although he also argues that this has often occurred. As shots of mechanical hands indicate, systems can be designed to mimic an operator's hand-brain coordination. Farocki's protest against the Industrial Revolution is clearly made in the name of the human body. He is disturbed about the loss of manual skills that came about as weaving and other crafts became mechanized.

Of course, handwork was not the only casualty of industrialization. *As You See* includes a nice lament for the foot. Old drawings and diagrams shot by Farocki remind viewers of a time when the foot controlled tools. Later, the filmmaker notes, the foot was given the crude work: it propelled a wheel or pressed a pedal or was limited to walking. A 1934 photo of swaying glassworkers in an Opel plant provokes his nostalgia, for this craft soon disappeared from the auto industry. "For the last time work comes from a rhythm to which one can dance," says the narrator. And then comes Farocki's characteristic associative leap: "I imagine that industrial workers admired football players for their skilled footwork. Football players perform skills with their feet which are normally done only with the hands." Which leads to his hyperbolic conclusion: "It moves the workers deeply that they were once so skilled with their feet, more than any present-day loss." Now I doubt that that's the reason why working class people watch the games, but it's a striking coda to his dirge.

There may be little information in *As You See* that will be new to anyone who is familiar with the history of technology. But much modern art works with found material, structuring it in an original manner. Through his unexpected juxtapositions of images and ideas, this filmmaker makes the familiar strange again, and therefore interesting to reexamine. The film's fast pace will also keep viewers on their toes. Farocki avoids dwelling on anything, probably because he doesn't want to push his startling comparisons any farther. They are meant to be suggestive—merely suggestive, but very suggestive.



By presenting unusual "found" images, avant-garde filmmaker Harun Farocki shocks his audiences into rethinking their attitudes about technology. This bizarre cannon mounted on a ploughshare is disturbing because it reverses the biblical injunction to turn swords into ploughshares.



This 1937 photograph of a bridge over the Saale River is framed so that the space beneath the arches resembles the nave of a cathedral. Both Bitomsky and Farocki suggest that the Nazi cult of the road inspired an almost religious devotion, and their films should cause audiences to wonder how different the present-day obsession with cars and driving is.

The Poetic and the Intellectual

The practice of combining the poetic with the intellectual, which can be seen in the documentaries of Bitomsky and Farocki, does not come out of nowhere. The two filmmakers have absorbed the ideas of Roland Barthes, the French critic whose short poetic essays (almost prose poems) investigate what he calls the "mythologies" of contemporary culture—the highly arbitrary patterns of seeing the world that people generally accept as normal, rational, and sometimes even sacred. "There comes a point where you have assimilated Barthes's thinking to such an extent that you can't tell if an idea is his or your own, it seems so near and natural to you," Bitomsky told me.

Moreover, as teenagers, both Bitomsky and Farocki were influenced by the dense, epigrammatic writings of Theodor Adorno and Walter Benjamin, which investigate the power of the modern mass media. The French director Jean-Luc Godard attracted them as well, for his films address the relationship between politics and image. What kind of style emerges from the imitation of such models? As historian Martin Jay once wrote, "Reading a piece by Adorno or Benjamin brings to mind a comment the filmmaker Jean-Luc Godard is once said to have made when asked if his films had a beginning, a middle, and an end. 'Yes,' he replied, 'but not necessarily in that order.' "

Barthes, Adorno, Benjamin, and Godard are so central to post-war European culture that educated German audiences can be expected to place the works of Bitomsky and Farocki in a recognizable context. But in the United States the same intellectual tradition is less familiar to most people, which presents an obstacle to the reception of poetic documentaries. Here the names Bitomsky and Farocki are known only on the art-house and museum circuit. Consider the fate of Bitomsky's *Reichsautobahn*. In this country, it has been screened at places like the Film Forum in Manhattan, the Brattle Theater in Cambridge, Mass., and the Film Center at the Art Institute of Chicago. In West Germany, by contrast, it has played more than once on national television. In 1987, it won the annual television award of the association of schools of adult education.

We may soon get more chances to see films by Bitomsky and Farocki. The Goethe Institute, which receives money from the West German government to take German culture abroad, is considering including them in an upcoming series of films on technology and industry. Even so, these works may have difficulties finding an American audience: not only is their cultural context strange to the majority of us, but our technical intelligentsia and our aficionados of modern art remain, for the most part, distinct and disparate communities. The two cultures are split, and poetic documentaries about technology fall right into the crack.

This need not be the case, of course. I wrote earlier in *Technology Review* about the surrealist poet and filmmaker Humphrey Jennings who edited a collection of reactions to the Industrial Revolution called *Pandaemonium*. Jennings comes to mind because, like Farocki, he has arranged found materials concerning technology to yield startling juxtapositions. Bitomsky's tie to Jennings is even clearer. In 1976, he made a documentary about this Englishman's life and work. There is a history of artists' taking technology as their theme; what we need now are more people schooled in both realms who could form an audience for them. ■

Hartmut Bitomsky's Reichsautobahn *(35-mm, 92 minutes) in German with English subtitles can be rented from Barbara Scharres, The Film Center, School of the Art Institute of Chicago, Columbus Drive at Jackson Boulevard, Chicago, Ill. 60603. Prints can also be rented or purchased from Big Sky Film Production, Hauptstrasse 18, Gartenhaus 1 St., D-1000 West Berlin 62, telephone 30-782-8234.*

Harun Farocki's As You See *(16-mm, 72 minutes) with English narration can be obtained from Basis-Film Verleih GmbH, Guentzelstrasse 60, D-1000 West Berlin 31, telephone 30-853-3035.*



Making Plastics That Biodegrade

BY ANN GIBBONS

After decades of creating stronger and more durable plastics, chemists have become reverse alchemists: they are designing plastics that disintegrate. Six-pack yokes that crumble, garbage bags that degrade, and medical sutures that dissolve have reached the market.

The plastics industry has plenty of incentive. Pressure has been growing to reduce the amount of waste that clogs landfills, strangles wildlife, and litters beaches. Plastics now account for 7.2 percent of the weight of all municipal refuse and are the fastest-growing type of trash in landfills. The tonnage is expected to double by the year 2000 if Americans continue to increase their use 8 percent annually,

Mounting litter and concern about harm to wildlife have spurred efforts to create plastics that fall apart.

as they have for the past 25 years. The mountains of synthetic waste are a legacy for future generations, since plastics normally take some 200 years to degrade.

To limit this legacy, at least 15 states are writing laws that restrict the use and disposal of plastic products. The federal government has banned the dumping of plastics in the ocean, and the U.S. Navy recently canceled a contract to buy 11 million plastic food and trash bags.

Many people see degradable plastics as part of the solution. Congress held hearings on the materials last summer and introduced a flurry of bills to encourage their use.

Yet bugs in the new technology remain to be solved. Degradables cost more to make and usually aren't as reliable as conventional plastics: it's hard to sell garbage bags that fall apart before they reach the landfill. Some of the new plastics don't dissolve entirely, and no one knows how safe the remaining residues are. Environmental groups also fear that the advent of disposables may hinder efforts to recycle longer-lived plastics.

The industry itself has invested in the technology somewhat reluctantly. "We're unashamedly market-led," says Roger Lloyd of ICI Biological Products, a division of Imperial Chemical of Britain. For consumers, that means that even if they want plastic products that dissolve, they can't always find them. For example, degradable six-pack yokes that won't strangle fish, birds, and seals are available only in states that require them. But the field promises to grow as more regulations take effect and more consumers demand the new products.

Designing the Technology

The marketplace today boasts more kinds of plastics than metals, with properties as different as lead from gold and aluminum from iron. What these diverse materials share is an underlying strength and flexibility that make them ideal for products ranging from an airplane's nose cone to a disposable diaper lining. Plastics can be devised so they don't rust, rot, mold, or lose their integrity when wet, heated, or frozen.

The chemistry of plastics underlies this indestructibility. They are composed of long chains of repeating hydrocarbon molecules. Those chains, called polymers, are so tightly bound that they are impenetrable to the microorganisms that dissolve paper and most other garbage.

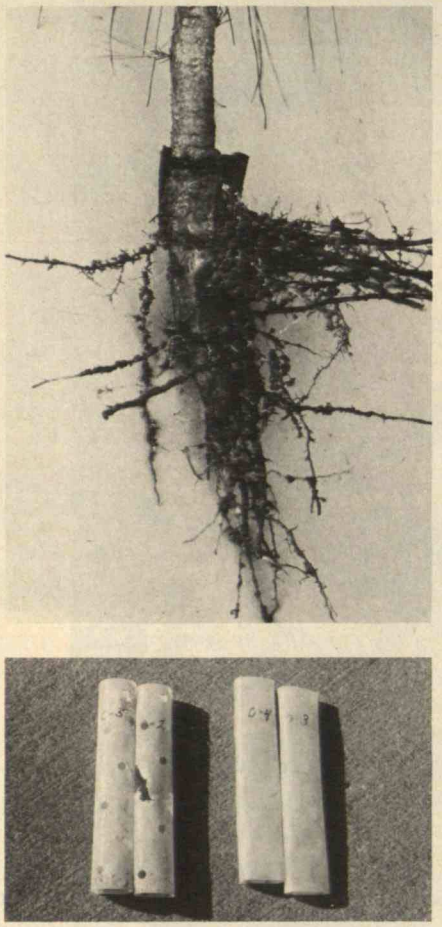
The challenge for chemists is to find a way to weaken those synthetic chains without robbing the plastic of its strength. In pursuing this goal, scientists have focused on three categories of disintegrating plastics: biodegradable, chemically degradable, and photodegradable.

Biodegradable plastics incorporate weakening agents into their chemical structures that allow fungi and bacteria to grab hold and digest the hydrocarbon chains. However, these materials are costly because they are difficult to make, often requiring new steps in the manufacturing process.

Research on biodegradable plastics owes much to Union Carbide chemist James Potts, who screened a variety of materials in the 1960s to see which the bacteria in soil would consume. He discovered that organisms gobbled up natural polymers such as cornstarch, cellulose, cotton, and silk, but that they ate only one class of synthetic polymers: polyesters. These polymers have "ester groups," such as animal and vegetable fats and oils, bound into their chemical backbone. Enzymes from microorganisms seek out an ester group and connect with it, using water to convert it into an alcohol and acid that the organisms can then digest. Biodegradable polyesters also consist of shorter chains and have low melting points, so they can be swollen with water. This softens their molecular structure and makes them more susceptible to the work of enzymes.

Although biodegradable polyesters are too expensive to be used in packaging, the biggest market for plastics, they are valuable in specialty areas such as medicine and agriculture. American Cyanamid Co. manufactures degradable sutures made of polyglycolate acid. Once inside the human body, the sutures slowly dissolve into harmless carbon dioxide and water, disappearing completely after three months. The material costs about $15 a pound to manufacture, compared with the average price of $.65 a pound for conventional plastic.

In the 1970s, the U.S. Forest Service



A biodegradable plastic container (above) that will eventually disintegrate protects a seedling (top) during the first year of life. The U.S. Forest Service tested this sheath during the 1970s but discontinued its use because, like many degradable plastics, it proved too costly.

PHOTO: U.S. DEPARTMENT OF AGRICULTURE

ANN GIBBONS is a science reporter for the San Diego Tribune. *From 1987-8 she was a Knight Science Journalism Fellow at MIT.*

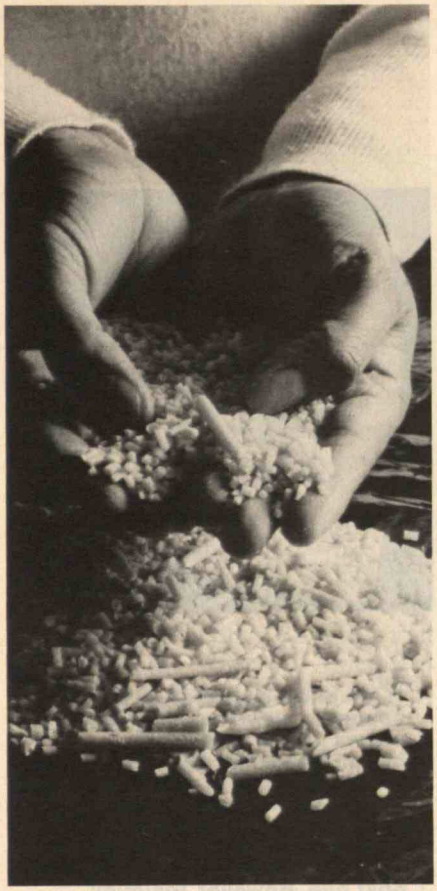
tested Poplycaprolactone, a biodegradable plastic developed by Potts, as a protective sheath for seedlings, according to James Barnett of Timber Management Research in Pineville, La. Rangers used a special tool to fire plastic "bullets" containing seeds into the soil with each step. The containers protected the plants as they took root during their first year of life, and then dissolved. To speed up the pace of reforestation, another company even designed polyester containers with fins that could be fired from airplanes. But the company abandoned the product because the plastic cost too much.

Bone Screws and Farm Mulch

Polyesters have become models for chemists trying to make biodegradable plastics for broader use. At the University of Maryland, William Bailey induces esters to form in conventional plastics derived from petroleum, such as polyethylene used in black trash bags and milk containers.

His technique uses free radicals, unstable atoms that are missing electrons in their outer rings, to break the bonds between molecules. This triggers a chain reaction that tears up the polymers into ester groups, which microorganisms can then attack. He can control how quickly the polymers dissolve—from months to years—by varying the number of esters the free radicals create. Bailey says his material has the strength and flexibility of conventional polyethylene but the biodegradability of a polyester. He even maintains that he can make the material in the same cheap commercial process used for most conventional plastics, but says he has had trouble capturing the interest of the packaging industry or the government.

Chemists at ICI in Wilmington, Del., rely on a different approach. They have developed a fermentation process to breed bacteria normally found in soil, just as brewers grow yeast for beer. When fed sugar and acid, these bacteria produce a polymer called PHBV (hydroxy butyric valeric acid) as a future source of energy, much as humans store fat. Chemists kill the bugs and harvest the powdery polymer, which they make into resins as strong as conventional plastic.



Purdue chemist Ramani Narayan's starch granules can be compounded with the polystyrene used to make trash bags. This creates a product that bacteria can digest. When the bags are discarded in soil, microorganisms eat the starch and then the remaining plastic powder.

ICI chemist Tom Galvin says PHBV would be particularly valuable in making agricultural mulch, as well as plates and screws that hold broken bones in place until they heal. Once inside the body or disposed in soil, bacteria would consume the plastic without poisoning the patient or polluting the environment. And because PHBV is entirely natural, the body's immune system would not reject it.

The drawback is that, as with many biologically degradable plastics, the inventors have yet to work out the details of large-scale manufacturing. Companies from diaper makers to tampon manufacturers to packaging firms have expressed interest in PHBV, but at $15 a pound the cost is still too high. An ICI official says his company hopes to reduce manufacturing costs to $2 a pound within the next few years. Since the material isn't derived from petroleum products, its price should remain constant if oil prices rise.

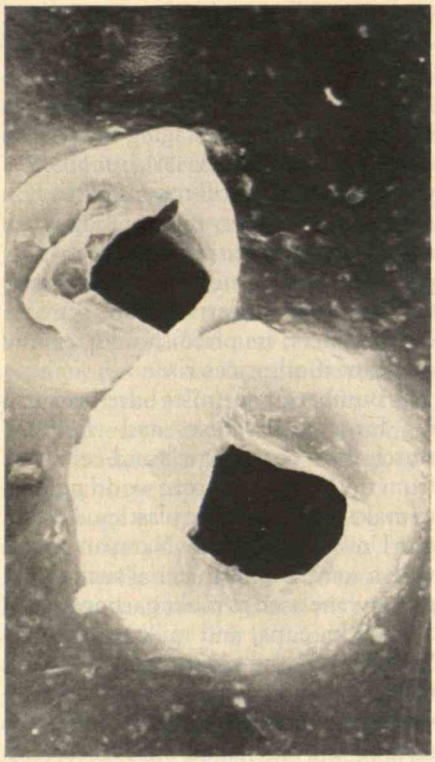
A number of chemists have been using farmers' surpluses and wastes—starch from corn kernels and cellulose from the husks and from wood pulp—to make biodegradable plastics. At Purdue University, Ramani Narayan works with a conventional material such as the polystyrene used to make garbage bags, Styrofoam cups, and milk containers. Since starch and plastic mix about as well as oil and water, he adds an emulsifying agent that helps graft the polystyrene as a side chain onto the starch backbone. The result is a copolymer (made of two polymer chains) with as much as 20 to 30 percent cornstarch or cellulose evenly distributed throughout the plastic. Microorganisms in soil or water that feed on the starch break down the plastic into powder and then consume it within a few years. This approach offers versatility: different plastic polymers can be grafted to the starch or cellulose backbone.

Narayan expects to sell manufacturing rights within a year for products such as fast-food wrappings and garbage bags. But his material has a drawback: it can become moldy if exposed to bacteria in food. He's now working on similar blends using wood pulp, which would not degrade until exposed to iron salts in soil.

Cheaper but Longer-Lived Varieties

In contrast to biologically degradable plastics, those that are chemically degradable do not break down completely. Instead, fillers, often starches,

PHOTO: RAMANI NARAYAN





This photograph taken with a scanning electron microscope shows where bacteria have begun to eat the starch granules embedded in degradable plastic film. Products made of such film, such as this garbage bag, begin to fall apart after several months in a compost pile. However, residues whose toxicity is unknown remain.

added during the traditional manufacturing process simply cause the material to crumble, leaving behind a residue. Although less effective, these products tend to be cheaper, since the techniques for making them are less delicate and labor intensive.

For example, Canada's St. Lawrence Starch Co. makes a degradable concentrate consisting of a plastic polymer coated with cornstarch. An ester such as corn oil joins the final batch as an oxidizing agent that will help force the polymer chain to break apart. Once a plastic bag made of the material is thrown in soil, bacteria eat the starch, leaving behind a porous structure. Meanwhile, the corn oil reacts with salts in the soil or water to generate peroxides, which attack the bonds in the remaining plastic. Eventually, the pieces become so small that bacteria can digest most of them. Under ideal conditions, about 50 percent of the plastic resin degrades into powder after six months and 100 percent in a few years, according to St. Lawrence Starch.

Charles Swanson, a research chemist at the U.S. Department of Agriculture's Plant Polymer Research Laboratory in Peoria, is devising a degradable plastic that is up to 60 percent corn. The latter is so well integrated that the plastic absorbs water evenly, so that enzymes have no trouble breaking down the starch. These plastics have been blown into films that have been tested for use as a crop mulch. However, as the starch level rises to allow the plastic to break down more readily, it becomes less durable—to the point that it tears like paper, Swanson says. That's unacceptable for most uses. And Agritech Industries of Gibson, Ill., which has licensed the technology, is having trouble finding the right equipment to make the concentrate in large quantities.

Finally, the third type of degradable plastic does its magic when exposed to light. In photodegradables, "carbonyl groups"—composed of ketones, carbon, and oxygen molecules—absorb ultraviolet light from the sun, triggering a chain reaction that breaks the bonds between molecules. The plastic becomes brittle and crumbles. Most degradable plastic bags, six-pack yokes, and other plastics now on the market rely on this process. However, like chemically degradable plastics, these materials leave behind residue, and may take take years to fall apart.

The Big Picture

This raises the question of what exactly consumers get when they buy products that are labeled degradable. All the new plastics need just the right conditions to break down. Photodegradable plastics can solve the litter problem only if they are exposed to sunlight—a problem in landfills and during the winter. Chemically degradable plastics must be buried in dirt or submerged in water to disintegrate. And biodegradable plastics need oxygen and moisture so the bacteria that eat them can survive. Even newspapers, which normally degrade quickly, can still be legible after 10 years in landfills that lack water and oxygen.

The USDA's Swanson maintains that manufacturers' claims of quick degradability are often overly optimistic. "There hasn't yet been a definition of biodegradable," he says. A product may claim to disintegrate, but its label doesn't specify what conditions are needed, how long it takes, or what material remains.

Greg Olson, a microbiologist at the U.S. Bureau of Standards, says his agency has just begun testing degradable plastics, and agrees that there will soon be a need for standards. But the bureau won't be issuing new rules in the near future. First, it must do a market survey to justify them, Olson points out. Then the bureau consults the American Society for Testing Materials to help develop standard testing procedures. The bureau might even produce its own degradable plastic that could be purchased and duplicated by manufac-

PHOTO: ARCHER DANIELS MIDLAND CO.



Many states require six-pack rings, a curse for wildlife, to be photodegradable. But they will disintegrate only in sunlight—a problem in landfills. All degradable plastics require specific conditions to break down, and no standards establish how long that should take.

turers. However, any standards would be only voluntary unless EPA, Congress, or state governments stepped in.

That's a definite possibility. One bill introduced by Rep. H. Martin Lancaster (D-N.C.) last summer requires EPA to mandate that, within two years, all plastics made in the United States be degradable. Products with no practical alternatives would be the only exceptions.

Some states have taken action rather than wait for the federal government. A notable example is Florida, where sweeping new legislation bans nondegradable six-pack yokes, shopping bags, and the polystyrene foam and plastic-coated paper used to hold food. Some 16 states, including Oregon, Minnesota, Massachusetts, and New York, require all six-pack yokes to be photodegradable.

Surprisingly, both industry officials and environmentalists agree that such measures are premature and could ultimately prove counterproductive. Chemical companies still want to perfect the technology before relying on it. And environmentalists fear that the residues that remain after many plastics break down could contaminate groundwater supplies, as well as prove hazardous to animals that ingest them. Some industry officials have claimed their end products are safe, but no independent testing of the residue has been done, says Jeanne Wirka of Environmental Action Foundation. Decaying plastics also release gases, such as methane, that can be flammable. Wirka maintains that "it would not be good policy to make a national commitment to degradable plastics without first knowing their environmental impact."

Environmentalists also worry that degradable plastics might interfere with efforts to recycle plastics, a business that is just starting to pick up. Americans recycled 150 million pounds of plastic soft-drink bottles in 1987, up from only 8 million pounds in 1979. Adding degradable plastics to material destined to be recyled could ruin its usefulness.

Finally, many environmental groups maintain that the best approach is for consumers to substitute other materials entirely where possible, using paper packaging and cloth diapers, for example. All these concerns mean that even if degradable plastics work perfectly and are found to be safe, they will undoubtedly be just one part of a comprehensive strategy to get rid of waste—used mainly for products such as garbage bags that can't be recycled, or for those that have no good substitutes.

Some analysts maintain that the solution lies in new, enlightened management of landfills that combine recycling and degradable technology. At least 60 percent of what goes into mountains of trash is already biodegradable, EPA studies show. ICI's Lloyd is among a vanguard that says landfills should be operated more like giant compost heaps, with managers taking steps to ensure that degradables rot quickly. "We have to look at creatively managing landfills, not as a bury-and-forget-it approach but as a recycling back to nature," he says. The novel plastics now being developed can be part of this effort. ■

PHOTOS: CENTER FOR ENVIRONMENTAL EDUCATION



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Reviews

VIDEO

The Computer's Future

Knowledge Navigator
5 minutes, 45 seconds
Available from Apple Computer

BY ROBERT HOWARD

To the strains of classical music, a young professor enters his sunlit study and calmly removes his tweed jacket. On his perfectly ordered antique desk lies a thin plastic booklike object that opens to reveal a computer screen. Almost instantly, a figure appears in a window on the screen, dressed in a white shirt and bow tie and vaguely resembling Pee Wee Herman. "You have 3 messages," this "agent" announces in flawless English—one from "your research team in Guatemala, just checking in," another from a student asking for a second extension on his term paper, and a third from "your mother." The professor impatiently taps the figure on the screen, stopping it in mid-phrase. "Reminding me about my father's birthday party," he says, completing the sentence.

Thus begins *Knowledge Navigator,* a new video produced by Apple Computer Corp. Set in the year 2010, the video follows a Berkeley geography professor as he prepares for his afternoon lecture. In the course of the video, the professor, with the help of his computerized agent, reviews his notes from last year's lecture, pulls up articles from his personal database, copies video maps from a nationwide university data network, and creates an on-line simulation with a female colleague at a distant university.

Knowledge Navigator is Apple's vision of the computer of the future. Ideas that today are on the cutting edge of computer science—artificial-intelligence techniques such as automatic voice recognition and natural-language understanding, and a terminal that combines text processing, telecommunications, and video—appear here as standard features of a typical personal computer. First shown in early 1988, the video has been seen by thousands, primarily at educational institutions, and has sparked widespread interest.

But *Knowledge Navigator* is about far more than one company's version of computer evolution—as became clear at a recent showing of the video to some 400 computer scientists at the annual meeting of Computer Professionals for Social Responsibility (CPSR) at Stanford University in California. In the words of CPSR program chair Bradley Hartfield, who moderated a panel discussion of the video, *Knowledge Navigator* is really about "our technological dreams and myths."



All Too Human

Although it's a video about the computer of the future, *Knowledge Navigator* is loaded with visual references to the past. The professor's study looks as if it could have been designed by Frank Lloyd Wright. And the icons on the screen that signal the computer's various functions are quaintly old-fashioned—a 1930s movie camera for video, Bell Telephone's classic 1948 black dial phone for telecommunications. Clearly, the message is that as the computer becomes more advanced, it will also become more familiar and unthreatening. As Larry Tesler, Apple vice-president for advanced technology, put it at the CPSR meeting, *Knowledge Navigator* is about "the humanization of computer use."

All the more striking, then, was the way most viewers at the meeting—expert computer users all—reacted to the video. They hated it. Among the words used to describe it were "insulting" and "scary."

Some of the criticisms concerned the way *Knowledge Navigator* blithely assumes that extremely complicated problems in artificial intelligence will be resolved over the next 20 years. It's not merely that the professor's programmed agent speaks fluent English and understands complicated spoken commands—tasks that are proving far more difficult than most computer scientists used to think. By presenting the agent in this way, the video intimates that we will soon be able to relate to a computer pretty much as we do to another human being.

This is not only unrealistic; it undermines the video's explicit message about the humanization of computer use. For in a world where computer-generated agents can not only understand our speech but instantly grasp the context of our requests and even anticipate our needs, the role of human thinking and activity comes to seem superfluous. According to a member of the audience, one student who had seen the video commented: "What does the bow tie need him for?"

A Reflection of the Self

What upset the computer scientists even more was the video's implicit image of the social relations of computing. In the world of *Knowledge Navigator,* programmed agents seem human, but people treat each other as one might treat a machine. In fact, the interaction between the professor and his simulated agent provides the model for his human relationships as well.

The agent not only has the look of a valet; it is treated like one. At one point, the professor asks the agent to bring to the screen last year's lecture notes. After barely a moment's glance, he snaps, "No, that's not enough. Pull up all the new articles I haven't read yet."

This may not seem so bad a way to treat what is, after all, only a computer-generated device. But this same selfishly expedient attitude colors the professor's relationship with his human colleague. According to the plot, he is trying to get the colleague, who has recently published a well-received article on the spread of the Sahara desert, to give a brief presentation "on the big screen" during his afternoon lecture. In the course of their conversation, the two combine some of their own data to create a simulation correlating desertification in the Sahara with the destruction of the Amazon rain forest.

While the professor's behavior toward his colleague borders on the obsequious,

ILLUSTRATIONS: LES KANTUREK

it's clear that this is just a strategy (dare we call it a "program"?), a convenient means to an end. His ultimate concern remains his own immediate needs. Upon seeing the simulation, he exclaims, "Interesting! I can definitely use this." But when his colleague asks for a copy—after all, half the data is hers—his only response is a noncommittal grunt.

According to panelist Peter Lyman, director of educational computing at the University of Southern California, the encounter in the video between the manipulative male professor and his rather submissive female colleague suggests how "even when we are given new technologies, we seem to want to use them to reinforce the authority relations that make us comfortable. I kept thinking, 'Why don't we just give the computer to the students and get rid of this self-centered narcissist!' "

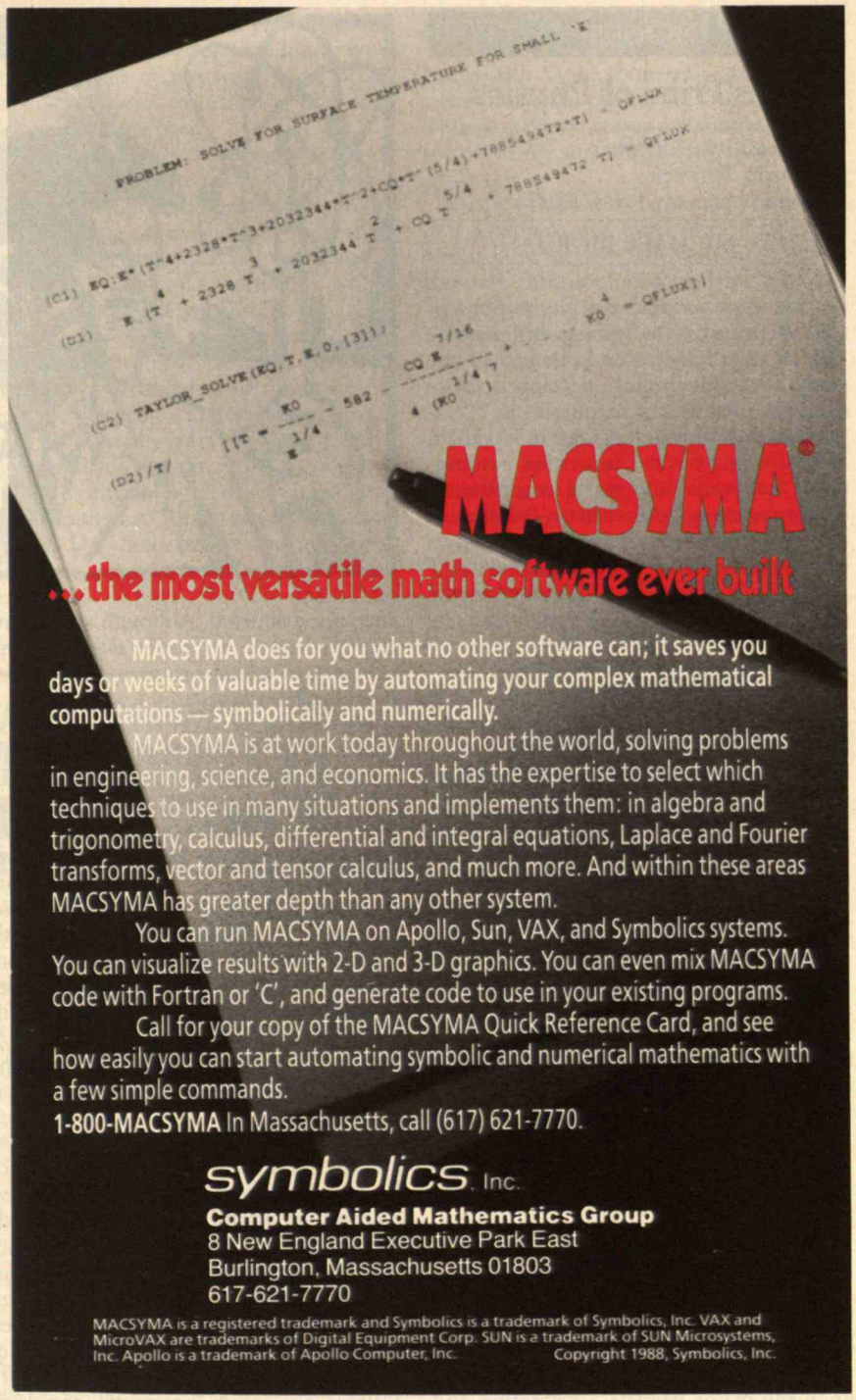
The allusion to narcissism is apt. In *Knowledge Navigator,* the computer allows the user to create a world over which he has total control—a world that provides a perfect reflection of himself.

A Caricature of Knowledge

This superficial view of human relations also leads to a superficial understanding of knowledge. Throughout the video, knowledge is viewed as a static given—disembodied "facts" able to be captured in data banks and brought to the screen as the need arises. But real knowledge is more dynamic than that. It is facts put into context and thus imbued with meaning, something created by people in dialogue. Although the professor certainly does a lot of talking in the video—to his agent and to his colleague—there is little real exchange. There is none of the argument and questioning of assumptions—whether someone else's or one's own—that are at the heart of intellectual inquiry. Just as the computer provides the professor with instant access to databases, networks, even other people and their work, it also appears to offer instant comprehension.

But this is as much a caricature of real thinking as the video's computer is a caricature of the challenges facing AI. *Knowledge Navigator* trivializes the computer's future, and our own.

ROBERT HOWARD is a senior editor of Technology Review.



BOOKS

The Tribe of Physics

Beamtimes and Lifetimes
by Sharon Traweek
Harvard University Press, $20.00

BY MICHAEL RIORDAN



HAVING exhausted the supply of primitive cultures, anthropologists have recently turned to the study of the much more developed societies and subcultures in our midst. "Repatriated" anthropology, as it is called, seeks to uncover the unwritten assumptions, traditions, and social organization of groups in modern society—whether a religious community, a corporation, or even a collection of scientists.

One such scientific community is the subject of *Beamtimes and Lifetimes: The World of High-Energy Physicists,* by Sharon Traweek of Rice University. Traweek has been observing physicists since the early 1970s, when she served as a public information officer at the Stanford Linear Accelerator Center (SLAC) in California (where I have worked for several years). Besides SLAC, her formal fieldwork has taken her to such outposts as the Fermi National Accelerator Laboratory near Chicago and Japan's National Laboratory for High-Energy Physics (KEK).

Historians and sociologists have been studying the high-energy physics community for years, but—speaking as a member of the "tribe" Traweek examines—I think her anthropological perspective offers fresh insights. In particular, her focus on the day-to-day interactions among physicists sheds light on the social rituals and relationships that shape scientific discovery.

Moral Tales and Intermarriage

The world of high-energy physics is not a single, uniform entity. It encompasses about 10 distinct communities, centered upon the major particle accelerators and colliders in Europe, Asia, and North America. The natives spend much of their time on jets or trains, speeding between universities and the research centers or traveling to and from capital cities, where the funds for this expensive branch of science are disbursed. Although such activities promote homogeneity, distinct subcultures manage to spring up at these far-flung laboratories.

For her study, Traweek chose to concentrate on SLAC, the subculture she knows best. Organized in the early 1960s, this highly successful national laboratory sports strong in-house groups with powerful, outspoken leaders jealously guarding their fiefs. These teams build and maintain the enormous particle detectors necessary to observe phenomena in the subatomic realm. User groups from outside universities wishing to employ these research facilities generally have to strike up alliances with SLAC group leaders. So massive and complex is the equipment that only the in-house scientists understand its every nuance.

The coin of this realm is "beamtime"—access to SLAC's high-energy particle beams. This scarce resource is doled out by the all-powerful lab director at periodic meetings of his Program Advisory Committee. Success in this competitive hierarchy, observes Traweek, is largely determined by the quality of one's ideas and the sensitivity of a group's particle detector. Only by combining these resources to obtain beamtime can high-energy physicists hope to make the important discoveries that will enhance their reputations and careers.

In describing the physical setting at SLAC, the complex detectors, and the theoretical ideas that guide experimental work, Traweek's treatment is uneven. Eloquent passages give way to statements that are misleading or just plain wrong. She is at her best, however, in discerning the educational practices and odd social customs of the natives. How does a fledgling graduate student or beginning postdoc come to see himself (or, rarely, herself) as a practicing scientist and attain full membership in this daunting community?

Having endured the lengthy rite of passage myself over a decade ago, I found Traweek's third chapter—"Pilgrim's Progress: Male Tales Told During a Life in Physics"—to be particularly astute. The journey begins, she notes, with "moral tales" told to the neophytes about the objectivity, meticulousness, and long hours of hard work required in their chosen profession. They are cautioned to put aside more "frivolous" concerns that may detract from the precious time they have to spend on physics.

At the postdoctoral level, the apprentices must cultivate self-assertiveness and independence if they are to survive and find a permanent position in high-energy physics. They have to leave textbooks behind and learn how to tap into the vast reservoir of oral information—the "gossip" exchanged daily by peers and superiors. From this, observes Traweek, "the young physicists learn the significance of the lifetimes of detectors, research groups, laboratories, careers, and ideas." Anxiety over the passage of time—and fear of obsolescence—in these five areas becomes an important driving force in their lives.

Here they also begin to establish the networks of colleagues whose support will be important for future success. In a field where a hundred scientists can be required to mount a major experiment, this network building is crucial. One of the ways these links are forged, notes Traweek, is by a kind of intermarriage. The group leaders find their best grad students and postdocs jobs with their allies, expecting these colleagues to return the favor one day. Such exchanges cement the alliances between groups and extend the power of the leaders.

Although the main focus of *Beamtimes and Lifetimes* is the subculture of SLAC, the author has sharpened her perspective by studying the customs of KEK in Japan, where she found far more cooperation among physicists and more interest in the common goals of the group. One's entrance to an experimental group comes at

An anthropologist sheds light on the social rituals shaping scientific discovery.

the end of graduate school, and membership lasts for life. Rather than pitting his postdocs one against another, as Traweek claims is the case in the United States, the Japanese group leader plays "a generative, nurturing role" in their personal and professional lives.

The Cooperative Edge

Although Traweek doesn't pursue the point, her cross-cultural study provides useful insights into the present difficulties of U.S. high-energy physics. During the 1970s, when she did her core research for this book, our country was the unquestioned world leader in the field. The competitive instincts fostered by their adversarial culture enabled U.S. physicists to reach the experimental frontiers far more quickly than their European or Japanese counterparts, who until recently had to be content with performing the thorough, detailed studies that confirmed the startling U.S. discoveries. One has only to read the roster of postwar Nobel prizewinners in physics to recognize how lopsided things have been.

During the 1980s, however, the Europeans have pulled even, and the Japanese are making impressive gains. U.S. physicists have done a great deal of soul-searching to discern why. Most lay the blame at the foot of the federal government, whose support of high-energy physics has fallen in real terms since its 1970 peak. But Traweek's thought-provoking book makes me wonder whether the more cooperative scientific cultures of our European and Asian partners are finally beginning to bear fruit.

On the other hand, Traweek's concentration upon SLAC to the virtual exclusion of other U.S. laboratories and university groups may exaggerate the adversarial nature of U.S. physics. SLAC is one of the most competitive—and most successful—centers for high-energy physics in the entire world. More cooperative subcultures exist—for example, at MIT or Fermilab. Thus, her observations may hold true only for the SLAC subculture she has examined so closely.

Despite these shortcomings, *Beamtimes and Lifetimes* is a groundbreaking work about how modern science functions. As the only anthropologist studying high-energy physics, Traweek brings a unique and valuable perspective to the study of this curious and important modern community.

MICHAEL RIORDAN is a physicist at the Stanford Linear Acclerator Center. He recently received the 1988 Science-Writing Award in Physics and Astronomy from the American Institute of Physics for his book The Hunting of the Quark *(Simon and Schuster, 1987).*

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CONTINUED FROM PAGE 28

ample, cost about $2 million. This figure is almost double the amount initially allocated, because the study design proved harder to carry out than expected.

There are more subtle costs as well in opening up the scientific process to greater control by outside scientists and general citizens. Participatory methods, such as those used in the Love Canal habitability study, carry the danger that the public's emotional estimates of risk may override reliable scientific estimates. The ability of organizations such as HEI to generate good science may tempt agencies to put increasing amounts of money into research, even when the real barriers to regulation are political. And nervous officials may use regulatory peer review as an excuse for delaying decisions by months or years.

In any event, peer review is a preventive measure, not a cure. The fate of the Thomas panel report suggests that once science is embroiled in serious political controversy, expert review is no longer sufficient to restore credibility.

Nevertheless, the costs of not opening up the scientific process are significant. Congress and our public agencies have to do more to ensure that public policy is based on trustworthy science. At the very least, regulatory peer review is an idea that has to be considered more seriously. This is especially true for agencies that have no mechanisms for subjecting their scientific work to critical review. Moreover, agencies with regulatory peer-review boards should consider having these groups review more decisions involving science.

Such changes won't always be easy for the scientists who contribute to regulatory policy. They will need to relinquish some of their professional autonomy. Instead of relying solely on self-regulation, they will have to participate in processes designed to increase public confidence and trust. ■

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CONTINUED FROM PAGE 80

Making More Votes Count

A simple change in the electoral college system could increase voter turnout and make individual votes more influential in determining the final results. So suggests Alan Natapoff, an MIT research scientist in the Department of Aeronautics and Astronautics' Man-Vehicle Laboratory, who on his own time has developed and proved a mathematical theorem that makes his case.

Natapoff proposes that the number of electoral college votes now equal to the number of House members be equal to the popular votes cast. And the two votes each state now gets for having two senators would be increased in proportion to the national popular vote. The winner in each state would continue to take all electoral votes. Since the number of electoral votes would increase as more people in any state voted for nominees, candidates might campaign harder in each state.

In states dominated by one party, citizens who want the other party to win the national election could deflate the victory of the dominant party by not voting. Today in these states no single vote can "make any appreciable difference in the expected final result," Natapoff points out, calling this a "subtle disaster."
—*Eugene F. Mallove*

The Continuing Pulse Threat

The U.S. government has long worried about the effects of electromagnetic pulse (EMP), created when a nuclear weapon explodes in or above the atmosphere. While the most susceptible weapons and communications and control systems have been shielded against EMP damage or temporary halting of their electronics, this "hardening" may be inadequate, according to Greg Makoff and Kosta Tsipis of MIT's Program in Science and Technology for International Security.

"Great uncertainty" remains about how many of our retaliatory systems would work after a nuclear attack, Makoff and Tsipis say in a recent paper. While missile submarines would survive, "there is some question" whether intercontinental ballistic missiles and bombers would still be available to fight a war. And the Soviets cannot be certain about their systems' se-

curity, either, the authors say.

Makoff and Tsipis predict that this uncertainty could lead to one of two outcomes: leaders in both countries could decide to launch a first strike, or to renounce the use of nuclear weapons.

Rents Rise for the Poor

Residential rents are increasing more quickly today than they have for two decades, and the low end of the market is bearing the brunt of the change. Efforts to rehabilitate rental units will further reduce the number of low-cost apartments in the future. So conclude William C. Apgar, Jr., associate professor at Harvard University's Kennedy School of Government, and graduate students Ruijue Peng of MIT and Jennifer Olson of Harvard.

Between 1981 and 1986 real rents—costs after accounting for inflation—"increased by nearly 15 percent nationwide," Apgar, Peng, and Olson say in a recent paper written for the Joint Center for Housing Studies of MIT and Harvard. Real rents went up by almost 25 percent in the West and by nearly 20 percent in the Northeast. Led by boosts in Boston, Philadelphia, Los Angeles, and San Francisco, "real rents have increased somewhat faster in the Northeast and West, but the Midwest and South also experienced sharp increases." Houston is the only metropolitan area where rents did not jump more than 10 percent.

In the luxury-rental sector, growth in the number of units increased vacancy rates and kept rental increases for those apartments to modest levels. But in the low end of the market, landlords in many metropolitan areas raised rents to cover increasing costs and make up for the 1970s' depressed rent levels.

The rent increases, coupled with lagging real incomes in renter households, mean that the percentage of renters paying more than 50 percent of their income for housing is rising, Apgar points out. For example, in 1983—the last year for which information was available at the time of the study—19 percent of heads of households aged 25 to 34 paid at least half their income for rent.

Without "concerted action" on the part of the federal government, the country can expect "further increases in the number of homeless individuals and families in the years ahead," Apgar predicts.

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Making Robots Smarter

Most of today's commercial robots are dummies. Usually they are immobile, clumsy, barely sensate, and unable to work in changing environments. But several robots developed at MIT's Artificial Intelligence Laboratory indicate how much more flexible and hence useful factory robots could be in the future.

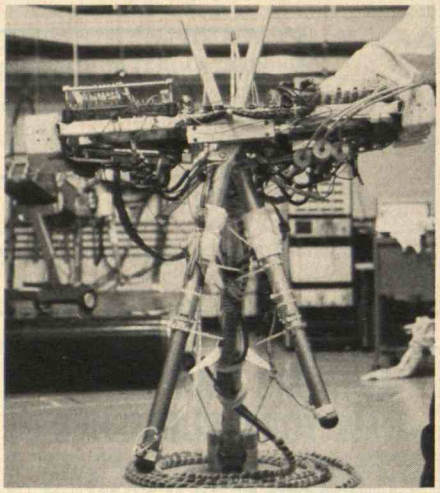
Consider a short, round robot named Herbert. As this machine rolls along in search of empty soda cans, it senses and avoids people and other obstacles. The machine uses a laser scanner to locate cans and tactile sensors to find a tabletop or floor. Simple sensors that look for reflected energy from infrared light determine hand-to-can distance, a similar optic sensor indicates when a can is in hand, and motor-torque readings in the arm and hand signal grasping force and can weight.

Scientists in the lab are testing other ideas on Seymour, a smaller, faster robot. Rodney A. Brooks, associate professor of electrical engineering and computer science, explains that the challenge with this machine is to allow it "to operate in an environment equivalent to walking along a crowded corridor or crossing a busy street." As Seymour wheels along at a brisk, five-mile-per-hour pace, heat sensors detect living bodies in its path, and cameras detect other obstacles. When Seymour senses that it is three seconds or so from a collision, it turns and proceeds in another direction.

Researchers are also working with more specialized machines, including a two-legged robot that can run at almost 12 miles per hour, a miniature six-legged vehicle, a cubic-inch robot "bug," dexterous hands with prehensile thumbs, and arms that can be controlled more easily and accurately than commercial models.—*The MIT Report*

Hidden Costs in Advanced Reactors?

Now that greenhouse warming is a top item on the policy agenda, people are talking about the reactor that Lawrence M. Lidsky, a professor in the MIT nuclear engineering department, discussed in *Technology Review* five years ago. (*See "The Reactor of the Future?" February/March 1984.*) Many experts consider the plant—which is smaller than conventional



This legged robot can run and do front flips.

nuclear power plants—safe, because during an accident the core cannot heat up enough to release fission products. But nuclear engineers differ on whether this reactor would be less costly than others. That factor could be critical in whether such a facility, whose parts would be factory produced, will be built.

Lidsky says the new kind of plant—a modular gas-cooled reactor that drives a gas turbine (an MGR-GT)—would be simpler to build, so that it would cost "substantially less" than $1,000 per kilowatt of electricity. That compares with American building costs of up to $3,000 to $4,000 per kilowatt for the nuclear power plants in use today.

But Norman C. Rasmussen, McAfee professor of engineering in the same department and author of a famous study on the probability of nuclear reactor accidents, says the public might not believe that MGR-GTs would be safer. That would translate into more regulation by the U.S. Nuclear Regulatory Commission and higher costs. "I have a sneaking suspicion that the large unit [an improved version of today's reactors] will be more economical," says Rasmussen. None of the calculations he has seen have convinced him otherwise.

Rasmussen calls for more research to answer the question. For his part, Lidsky says that three recent "worst case" tests in Germany of a reactor similar to the MGR-GT showed that the plant's safety features worked as predicted. Such tests could allay fears about safety and keep costs down, he says.

New Strategy for a Strategic Metal

The industrial world's "number-one critical metal" is ferrochromium, says John F. Elliott, director of MIT's Mining and Minerals Resource Research Institute. But today the United States is caught importing 85 to 90 percent of its supply of this metal, which is used in products as diverse as jet engines, aircraft landing gear, kitchen sinks, and high-performance steel chemical equipment.

To reduce our imports of ferrochromium—which largely comes from South Africa—Congress recently approved initial funding for research that could lead to domestic production. Elliott's institute, which will work with four other organizations on the research, will have the primary technical responsibility.

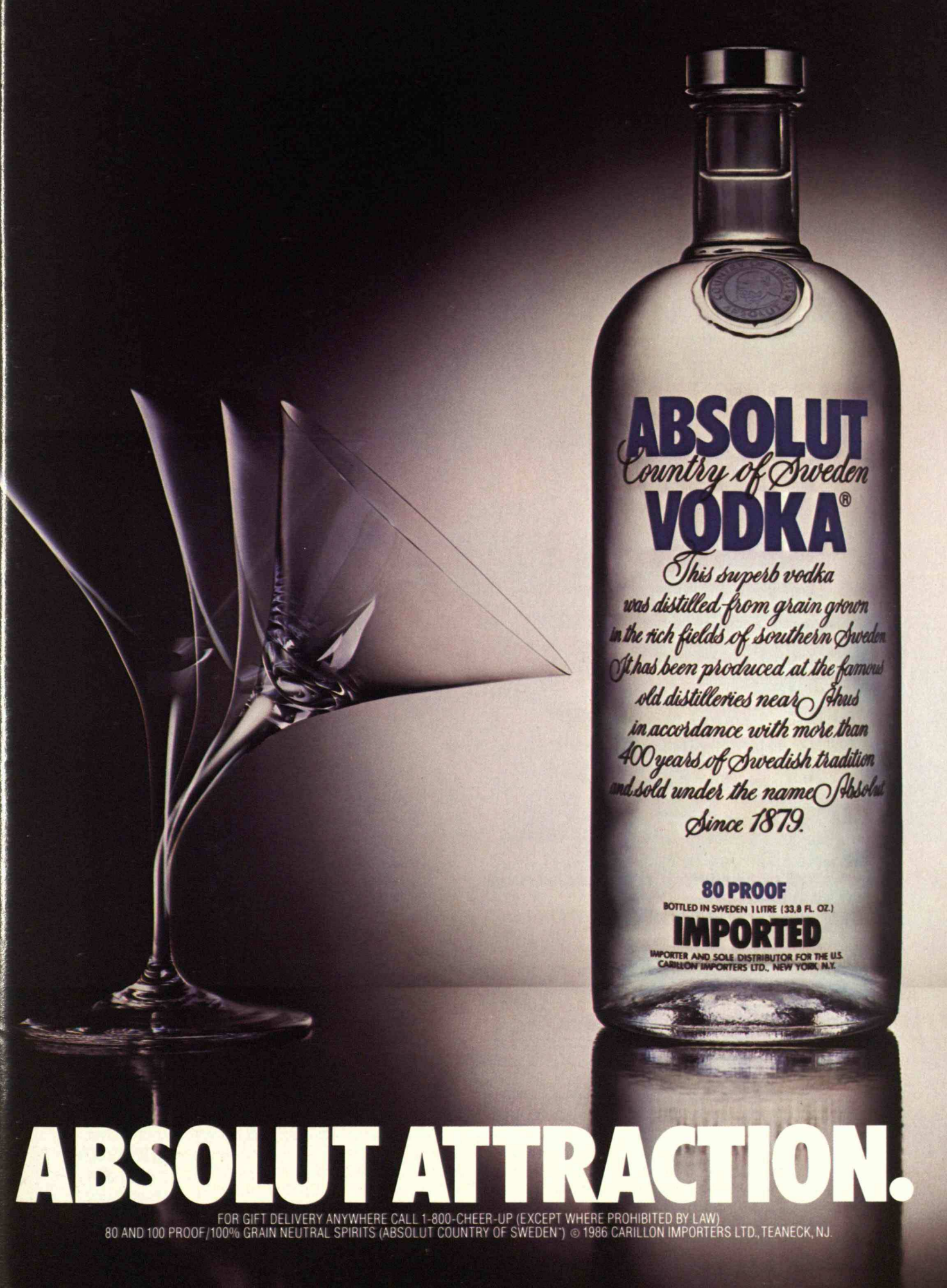
The work will entail testing a "plasma-arc" furnace to convert electricity into a high-temperature plasma that will smelt chromium ore and produce ferrochromium. In addition to allowing the use of domestic ores, plasma-arc smelting should increase yield and product quality, decrease pollution and the number of workers, and maybe reduce energy costs.

MIT in TR . . .

Starting with this issue, we welcome MIT's David Baltimore, a Nobel Laureate and director of the Whitehead Institute for Biomedical Research, as a regular columnist. Baltimore's comments will undoubtedly prove valuable given the increasing importance of life sciences at MIT and in engineering generally. In the mid-1970s, Baltimore was instrumental in questioning the safety of recombinant-DNA research, but he later concluded that the hazards weren't likely to materialize and the benefits outweighed the potential risks. He has spoken out on many controversial topics, including the human genome initiative—the effort to chart all the building blocks that make up our genes—and the federal bureaucracy used to evaluate genetic-engineering research.

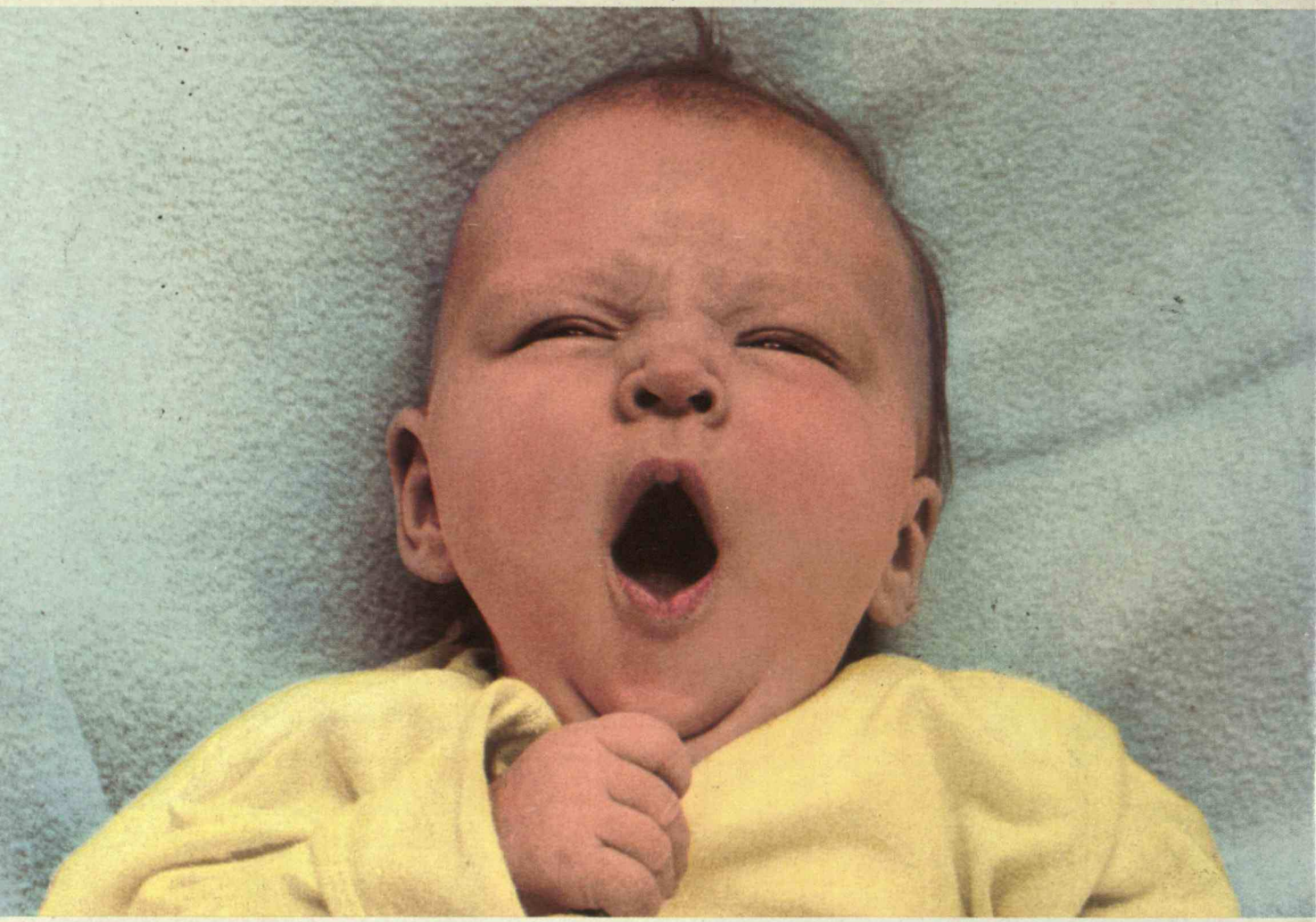
MIT Reporter continues on page 78

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